

## Chapter 3. Surface Water Monitoring and Assessment

### 3.1 Monitoring Program - General

Kentucky Division of Water has used NHD 1:24,000 scale maps for monitoring, planning, and assessment since 2004. As noted in Chapter 2, there are over 90,000 miles of streams in the commonwealth at this resolution. Of particular interest in this 2008 IR are new 305(b) assessments of two BMUs, the 4-Rivers - upper Cumberland and Green – Tradewater, which were the focus of monitoring in water-years 2005 and 2006, respectively. Table 3.1-1 provides population of stream miles for those two BMUs by river basin.

Table 3.1-1. Total stream miles (NHD 1:24,000 scale) of respective river basins in the 4-Rivers – upper Cumberland and Green – Tradewater BMUs.

4-Rivers - Upper Cumberland BMU, including Ohio River minor tributaries.....	21,166
upper Cumberland River sub-basin .....	10,433
4-Rivers sub-basin .....	10,733
(lower Cumberland, Mississippi, adjacent Ohio and Tennessee rivers)	
Green – Tradewater BMU .....	23,795
Green River basin including Ohio River minor tributaries .....	18,858
Tradewater and associated Ohio River minor tributaries .....	4,937

In this reporting cycle, primary monitoring occurred in 23 of the state's 42 eight-digit HUCs (hydrologic unit codes) established by the U.S. Geological Survey (Figure 2.1-1). Table 3.1-2 provides data on the number of assessed waterbodies, segments and types of waterbodies per the monitoring program for water-years 2005 - 2007. In the 4-Rivers - upper Cumberland BMU, those data include 20 stream segments on 16 streams in the one associated Ohio River subcoregional boundary (05140206); as well, the Green – Tradewater BMU data includes 34 stream segments on 26 streams assessed in the two adjacent Ohio River subregional boundaries HUCs (05140201, 05140202 and 05140203) (Figure 2.2-1). Most of these assessments stemmed from intensive multi-agency watershed monitoring in 2005 and 2006. However, some data more than five years old were considered valid this reporting period.

Table 3.1-2. Numbers of streams, stream segments, lakes and reservoirs assessed in the Upper Cumberland – 4-Rivers and Green - Tradewater BMUs of focus during the 2005 and 2006 water-years.

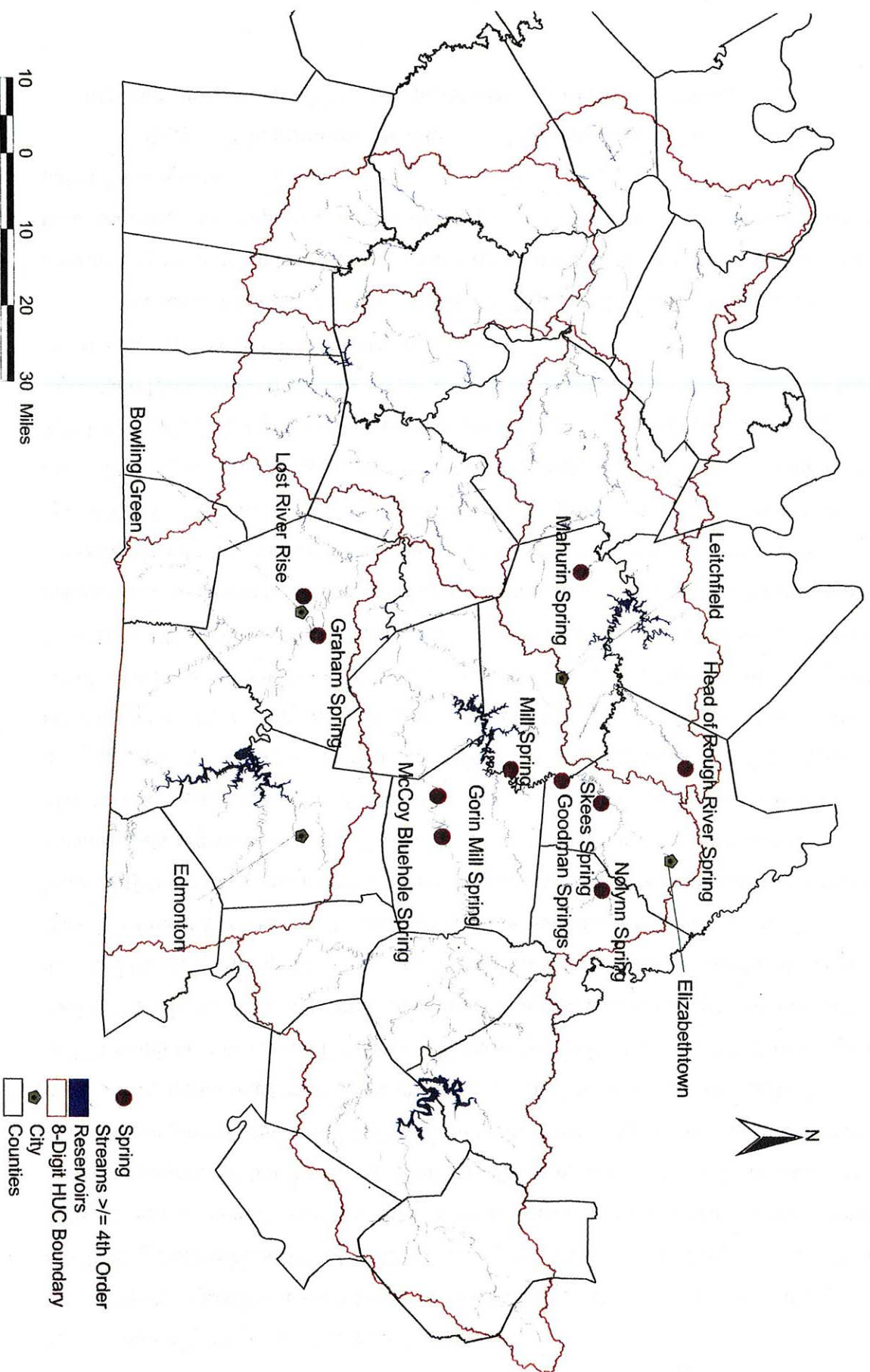
<u>BMU</u>	<u>Number of Streams</u>	<u>Number of Stream Segments</u>	<u>Number of Lakes</u>	<u>Number of Reservoirs</u>	<u>Number of Springs</u>
Upper Cumberland & 4-Rivers	410	562	12	19	0
Green - Tradewater	311	440	0	34	10
Total	721	1002	12	53	10

The 4-Rivers - Upper Cumberland BMU has the greatest number of natural lakes found in the commonwealth. Within this BMU 31 lakes and reservoirs were monitored, including 12 natural lakes found in the Jackson Purchase region (relict coastal plain). Those reservoirs monitored and assessed in the Green – Tradewater BMU numbered 34 (Table 3.1-2).

One waterbody type KDOW added to its monitoring program this monitoring period was springs. These are significant resources in karstic regions of the state. The Green – Tradewater BMU is the largest area of karst in Kentucky. As such, this landscape has many sinkholes, caves (e.g. Mammoth Cave) and subsurface streams and rivers, including associated springs. This portion of south-central Kentucky has long been an area of significant agricultural land uses, with a recent growing urban population, especially in the Bowling Green area; therefore, there are many potential sources and conduits to groundwater or subsurface (losing) streams for pollutants to readily flow into. Given the sensitivity of groundwater, subsurface (losing) streams and associated surface water resources to land uses in this porous limestone region, monitoring significant springs was made a priority for the KDOW. This effort was undertaken by KDOW's Groundwater Branch employing the Water Quality Branch's SOP used for surface water quality monitoring programs. The locations of those monitored may be seen in Figure 3.1-1.



Figure 3.1-1. Monitored springs in the Green River basin, 2006-7.



### 3.1.1 Ambient (Long-Term) Monitoring Network

**Water Quality.** Kentucky Division of Water's statewide ambient water quality monitoring network consists of 70 fixed stations (Table 3.1.1-1 and Figure 3.1.1-1). This network was expanded from 44 to 70 in 1998 following the watershed approach adopted by the commonwealth in 1997. Ambient stations were located in the downstream and mid-unit reaches of USGS 8-digit hydrologic unit codes upstream of major reservoirs and in the downstream reaches of major tributaries. The 4-Rivers – Upper Cumberland BMU had 14 ambient stations and the Green – Tradewater BMU had 17 ambient water quality stations (Table 3.1.1-1). The ambient stations of a watershed management unit were sampled monthly during the water-year the unit was in phase to be monitored. During the other four water-years of the watershed cycle, sampling frequency was reduced to bimonthly to devote more monitoring and laboratory resources to the rotating watershed water quality network (discussed later). Field measurements were taken for pH, dissolved oxygen, specific conductance and temperature; samples were analyzed for nutrients, metals and pesticides and herbicides if the streams drained predominantly agricultural areas. During the recreation season of May – October water quality samples are also collected to determine if levels of pathogen-indicating bacteria may be a concern for people who may recreate in these waters. The purpose of the ambient water quality network was to assess long-term conditions and trends on rivers and the larger streams of the state. In addition to KDOW's network, long-term stations were maintained by ORSANCO on the lower Licking, lower Big Sandy, lower Green, lower Tennessee and lower Cumberland rivers and by the USGS on the lower Tennessee River. Figures 3.1.1-2, 3.1.1-3 and 3.1.1-4 give the locations of ambient monitored stations (including associated biomonitoring stations) in the upper Cumberland River basin, 4-Rivers basin and the Green – Tradewater BMUs, respectively.

**Sediment Quality.** Sediment quality was determined at the ambient stations during the year in which monitoring occurred in a watershed management unit. At this time, sediment data supplement other data types; the data were not used for assessment, rather for screening purposes.

**Biology.** Fish, macroinvertebrate and algae data from the ambient stations provide long-term and trend information on mainstem of rivers and many major



tributaries. Most of the ambient biological stations were located on streams that also have water quality monitoring.

**Fish Tissue.** Fish tissue samples were obtained from 13 waterbodies or locations in the Upper Cumberland – 4-Rivers BMU and 12 waterbodies or locations in the Green – Tradewater BMU; additionally, 11 waterbodies or locations were monitored throughout Kentucky related to advisories. Tissue was analyzed for methylmercury, selenium, PCBs, chlordane, pesticides and herbicides. Results were used to determine if there were potential problems with contaminants in fish tissue that required further sampling. These results also were used to make fish consumption use support determinations. The widespread pollutant of concern in Kentucky fishes was methylmercury. The following criteria were used to determine level of use support: 0.0 – 0.30 ppm was full use support, greater than 0.30 – 1.0 ppm was partial support and greater than 1.0 ppm was nonsupport. If results were not elevated, no further fish tissue sampling was conducted. This method of assessment closely follows EPA's recommended application of basing water quality evaluation on fish tissue concentrations.

Table 3.1.1-1. Statewide primary water quality stations with upper Cumberland – 4-Rivers and Green – Tradewater BMUs highlighted in bold type.

River Basin & Stream	Station	HUC	Mile-point	Location	Latitude (dd)	Longitude (dd)	Drainage (mi <sup>2</sup> )	Station Type
<b>Big Sandy</b>								
<sup>a</sup> Tug Fork	PR1002	05070201	35.1	at Kermit, WV	37.8379	-82.40970	1277	hydrologic unit index site
<sup>a</sup> Tug Fork	PR1003	05070201	77.7	at Freeburn	37.56615	-82.14358	781	mid-hydrologic unit index site
<sup>a</sup> Levisa Fork	PR1006	05070202	115.0	nr Pikeville	37.46435	-82.52589	1229	hydrologic unit index site
<sup>a</sup> Levisa Fork	PR1064	05070203	29.6	nr Louisa	38.1160	-82.6002	2323	hydrologic unit index site
<sup>a</sup> Levisa Fork	PR1094	05070203	75.0	at Auxier	37.72905	-82.75436	1723	mid-hydrologic unit index site
<sup>a</sup> Beaver Creek	PR1095	05070203	95.0	at Allen	37.60280	-82.72754	239	major tributary
<sup>a</sup> Johns Creek	PR1096	05070203	26.6	at McCombs	37.6553	-82.5870	120	inflow to Dewey Res. major tributary
<b>Little Sandy</b>								
<sup>a</sup> Little Sandy River	PR1049	05090104	13.2	at Argillite	38.49053	-82.83404	539	hydrologic unit index site
<b>Tygarts Creek</b>								
<sup>a</sup> Tygarts Creek	PR1048	05090103	23.5	nr Lynn	38.5997	-82.9528	265	hydrologic unit index site
<b>Cumberland River</b>								
<b>Cumberland River</b>	PR1086	05130101	661.0	at Calvin	36.72244	-83.62537	519	mid-hydrologic unit index site
<b>Cumberland River</b>	PR1009	05130101	563.0	at Cumberland Falls	36.83558	-84.34015	1963	hydrologic unit index site
<b>Clear Fork</b>	PR1087	05130101	0.9	nr Williamsburg	36.72617	-84.14224	370	major tributary
<sup>a</sup> Rockcastle River	PR1010	05130102	24.7	at Billows	37.17137	-84.29673	604	hydrologic unit index site
<sup>a</sup> Horse Lick Creek	PR1051	05130102	0.1	nr Lamero	37.32011	-84.13841	62	special interest watershed
<b>Cumberland River</b>	PR1007	05130103	423.0	nr Burkesville	36.68879	-85.56670	6244	hydrologic unit index site
<b>Buck Creek</b>	PR1088	05130103	12.3	nr Dykes	37.0601	-84.4264	253	major tributary
<sup>a</sup> S. Fk. Cumberland R.	PR1008	05130104	44.8	at Blue Heron	36.6703	-84.5492	964	hydrologic unit index site
<sup>a</sup> Little River	PR1043	05130205	24.4	nr Cadiz	36.84104	-87.77731	268	major tributary
<b>Red River</b>	PR1069	05130205	49	nr Keysburg	36.64063	-86.97961	519	hydrologic unit index site



Table 3.1.1-1 (cont.). Statewide primary water quality stations with upper Cumberland – 4-Rivers and Green – Tradewater BMUs highlighted in bold type

River Basin & Stream	Station	HUC	Mile-point	Location	Latitude (dd)	Longitude (dd)	Drainage (mi <sup>2</sup> )	Station Type
<b>Kentuck River</b>								
<sup>a</sup> Eagle Creek	PR1022	05100205	21.5	at Glenco	38.7061	-84.8254	437	hydrologic unit index site
Kentucky River	PR1024	05100205	64.8	at Frankfort	38.2129	-84.8721	5409	hydrologic unit index site
Kentucky River	PR1066	05100205	30.5	nr Lockport	38.4450	-84.9569	6177	hydrologic unit index site
Kentucky River	PR1067	05100205	119.0	at High Bridge	37.8201	-84.7051	4587	hydrologic unit index site
<sup>a</sup> Elkhorn Creek	PR1098	05100205	10.3	nr Peaks Mill	38.2686	-84.81429	473	major tributary
<sup>a</sup> Dix River	PR1045	05100205	34.7	nr Danville	37.64176	-84.66113	318	hydrologic unit index site
Silver Creek	PR1099	05100205	5.9	nr Ruthon	37.73251	-84.43674	111	major tributary
Kentucky River	PR1058	05100204	171.5	nr Trapp	37.84675	-84.08182	3235	hydrologic unit index site
Red River	PR1046	05100204	21.6	Clay City	37.86468	-83.93316	362	hydrologic unit index site
N. Fork Kentucky River	PR1031	05100201	49.7	Jackson	37.55127	-83.38464	1101	hydrologic unit index site
Troublesome Creek	PR1090	05100201	7.2	nr Clayhole	37.46722	-83.27936	194	major tributary
<sup>a</sup> Middle Fk. Kentucky R.	PR1032	05100202	8.4	nr Tallega	37.55505	-83.59373	536	hydrologic unit index site
<sup>a</sup> South Fork Kentucky R.	PR1033	05100203	12.1	at Booneville	37.47513	-83.67082	692	hydrologic unit index site
Red Bird River	PR1091	05100203	5.5	nr Oneida	37.23690	-83.64500	192	major tributary
Goose Creek	PR1092	05100203	3.4	nr Oneida	37.23280	-83.69103	251	major tributary
<b>Licking River</b>								
Licking River	PR1062	05100101	226	at West Liberty	37.91470	-83.26169	335	inflow to Cave Run Reservoir
<sup>a</sup> Slate Creek	PR1093	05100101	10.0	nr Owingsville	38.1415	-83.7285	185	major tributary
Licking River	PR1061	05100101	78.2	at Claysville	38.52058	-84.18310	1996	mid-hydrologic unit index site
<sup>a</sup> N. Fork Licking River	PR1060	05100101	6.9	nr Milford	38.58123	-84.16566	287	major tributary
<sup>a</sup> S. Fork Licking River	PR1059	05100102	11.7	at Morgan	38.6033	-84.4008	838	hydrologic unit index site
<sup>a</sup> Hinkston Creek	PR1102	05100102	0.2	at Ruddles Mill	38.30471	-84.23778	259	major tributary
<sup>a</sup> Stoner Creek	PR1101	05100102	0.6	nr Ruddles Mill	38.3029	-84.2497	283	major tributary
<sup>b</sup> Licking River	PR1111	05100101	35.5	at Butler	38.7898	-84.3674	3384	hydrologic unit index site
Licking River	PR1062	05100101	226	at West Liberty	37.91470	-83.26169	335	inflow to Cave Run Reservoir
Licking River	PR1062	05100101	226	at West Liberty	37.91470	-83.26169	335	inflow to Cave Run Reservoir

Table 3.1.1-1 (cont.). Statewide primary water quality stations with upper Cumberland – 4-Rivers and Green – Tradewater BMUs highlighted in bold type.

River Basin & Stream	Station	HUC	Mile-point	Location	Latitude (dd)	Longitude (dd)	Drainage (mi <sup>2</sup> )	Station Type
<b>Ohio River Tributary</b>								
<sup>a</sup> Kimiconick Creek	PR1063	05090201	10.4	nr Tannery	38.57458	-83.18811	229	major tributary
<b>Salt River</b>								
<sup>a</sup> Salt River	PR1029	05140102	22.9	at Shepherdsville	37.98524	-85.71720	1197	hydrologic unit index site
<sup>a</sup> Salt River	PR1052	05140102	82.5	at Glensboro	38.00231	-85.06028	173	major reservoir inflow
Brashears Creek	PR1105	05140102	1.2	at Taylorsville	38.03040	-85.35154	262	major tributary
<sup>a</sup> Floyds Fork	PR1100	05140102	7.4	nr Shepherdsville	38.03447	-85.65936	259	major tributary
<sup>a</sup> Rolling Fork	PR1057	05140103	12.3	nr Lebanon Jct.	37.82267	-85.74787	1374	hydrologic unit index site
<sup>a</sup> Beech Fork	PR1041	05140103	48.0	nr Maud	37.83266	-85.29610	436	major tributary
<b>Green River</b>								
<sup>a</sup> Green River	PR1018	05110001	226.0	at Munfordville	37.2687	-85.8853	1680	hydrologic unit index site
Green River	PR1076	05110001	334.0	at Neatsville	37.1919	-85.1303	339	major reservoir inflow
<sup>a</sup> Nolin River	PR1021	05110001	80.9	at White Mills	37.55536	-86.03182	351	major reservoir inflow-tributary
<sup>a</sup> Russell Creek	PR1077	05110001	10.0	nr Branlett	37.16790	-85.47005	264	major tributary
Little Barren River	PR1078	05110001	6.3	nr Monroe	37.2264	-85.6776	250	major tributary
Bear Creek	PR1075	05110001	11.8	nr Huff	37.2488	-86.3612	137	major tributary
Barren River	PR1072	05110002	1.0	nr Woodbury	37.17069	-86.62052	2264	hydrologic unit index site
Drakes Creek	PR1074	05110002	8.0	nr Bowling Green	36.93492	-86.39227	5487	major tributary
Green River	PR1055	05110003	72.0	at Livermore	37.47832	-87.12694	6428	hydrologic unit index site
Mud River	PR1056	05110003	17.4	nr Gus	37.12324	-86.90042	268	major tributary
Green River	PR1103	05110003	150.0	nr Woodbury	37.18242	-86.61034	3136	hydrologic unit index site
Rough River	PR1014	05110004	62.5	nr Dundee	37.54720	-86.72139	757	mid-hydrologic unit index site
Rough River	PR1054	05110004	1.0	nr Livermore	37.49934	-87.06574	1068	hydrologic unit index site
<sup>b</sup> Panther Creek	PR1113	05110005	2.7	nr West Louisville	37.72497	-87.31513	371	major tributary
Pond River	PR1012	05110006	12.4	nr Sacramento	37.44179	-87.35285	578	hydrologic unit index site



Table 3.1.1-1 (cont.). Statewide primary water quality stations with upper Cumberland – 4-Rivers and Green – Tradewater BMUs highlighted in bold type.

<u>River Basin &amp; Stream</u>	<u>Station</u>	<u>HUC</u>	<u>Mile- point</u>	<u>Location</u>	<u>Latitude (dd)</u>	<u>Longitude (dd)</u>	<u>Drainage (mi<sup>2</sup>)</u>	<u>Station Type</u>
<b><u>Ohio River Tributary</u></b>								
<b><u>Highland Creek</u></b>	PR1110	05140102	14.0	nr Smith Mill	37.75699	-87.79514	145	major tributary
<b><u>Tradewater River</u></b>								
<sup>a, b</sup> <b><u>Tradewater River</u></b>	PR1112	05140205	25.0	nr Piney	37.39896	-87.90456	618	hydrologic unit index site
<b><u>Tennessee River</u></b>								
<b><u>Clarks River</u></b>	PR1106	06040006	17.6	nr Sharpe	36.96130	-88.49322	310	hydrologic unit index site
<b><u>W. Fork Clarks River</u></b>	PR1107	06040006	8.6	nr Symsonia	36.93245	-88.54396	186	major tributary
<b><u>Mississippi River</u></b>								
<sup>a, b</sup> <b><u>Bayou de Chien</u></b>	PR1109	08010201	13.6	nr Cayce	36.61543	-89.03025	103	major tributary
<sup>a</sup> <b><u>Mayfield Creek</u></b>	PR1042	08010201	13.7	nr Magee Springs	36.92989	-88.94297	274	major tributary

<sup>a</sup> Long-term ambient water quality stations that are also long-term ambient biological monitoring stations  
<sup>b</sup> Stations created since 2004 (these were changes necessary for sampler safety issues)

Figure 3.1.1-1. Fixed (long-term) ambient surface water quality network.

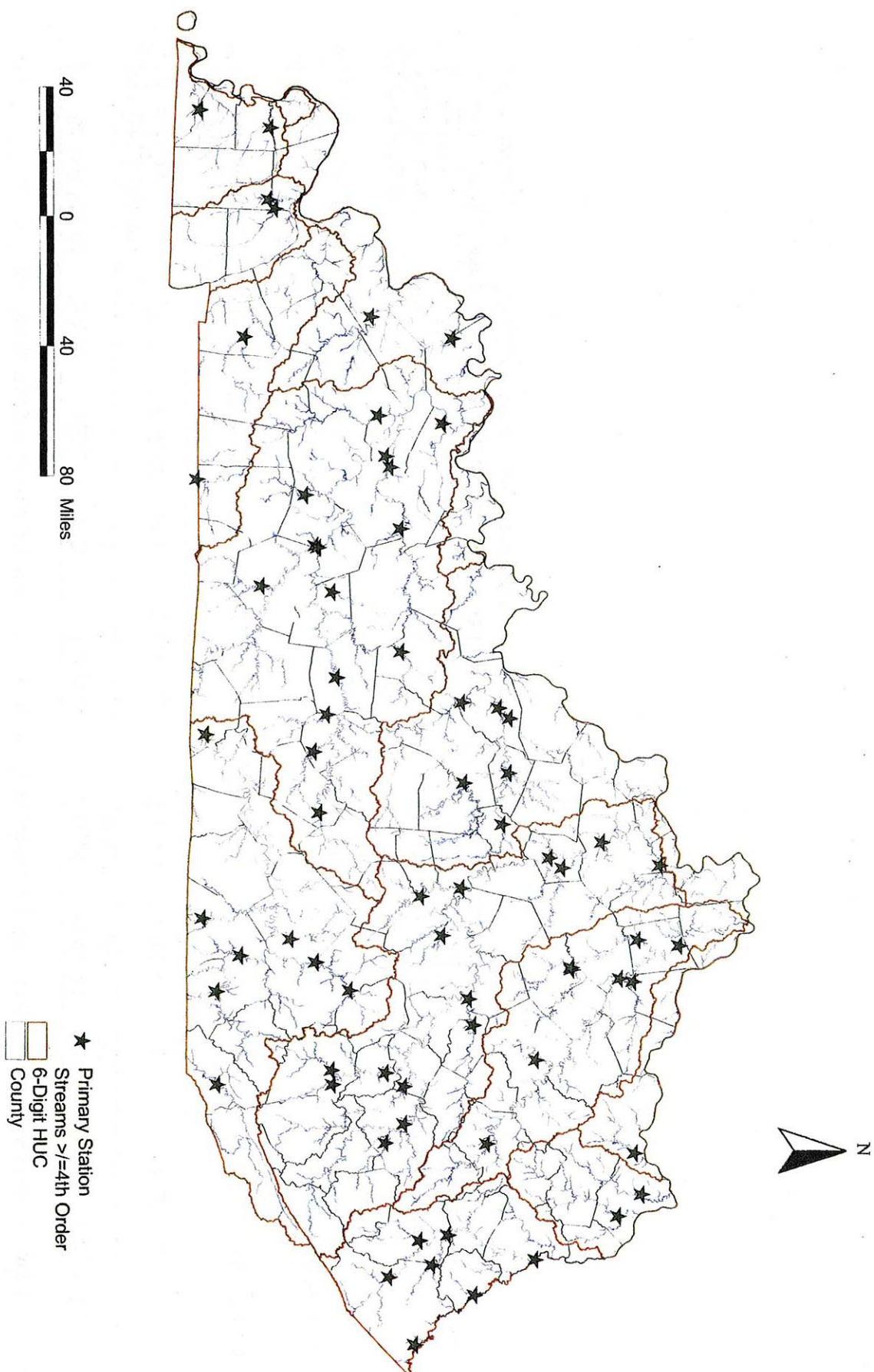




Figure 3.1.1-2. Targeted biological (including probabilistic sites) and ambient water quality monitoring in upper Cumberland River basin.

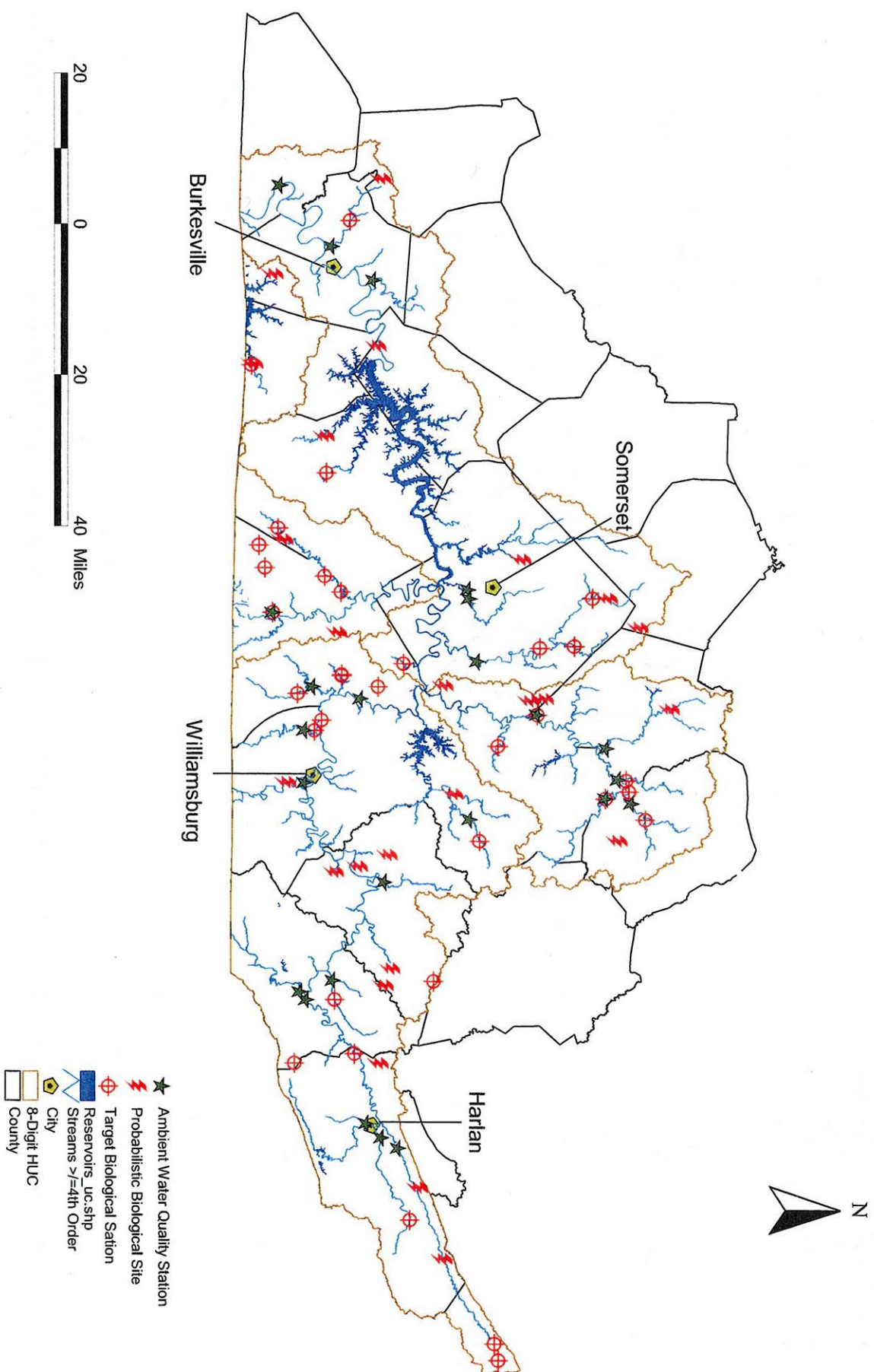


Figure 3.1.1-3. Target biological (including probabilistic sites) and ambient water quality monitoring in 4-Rivers basin.

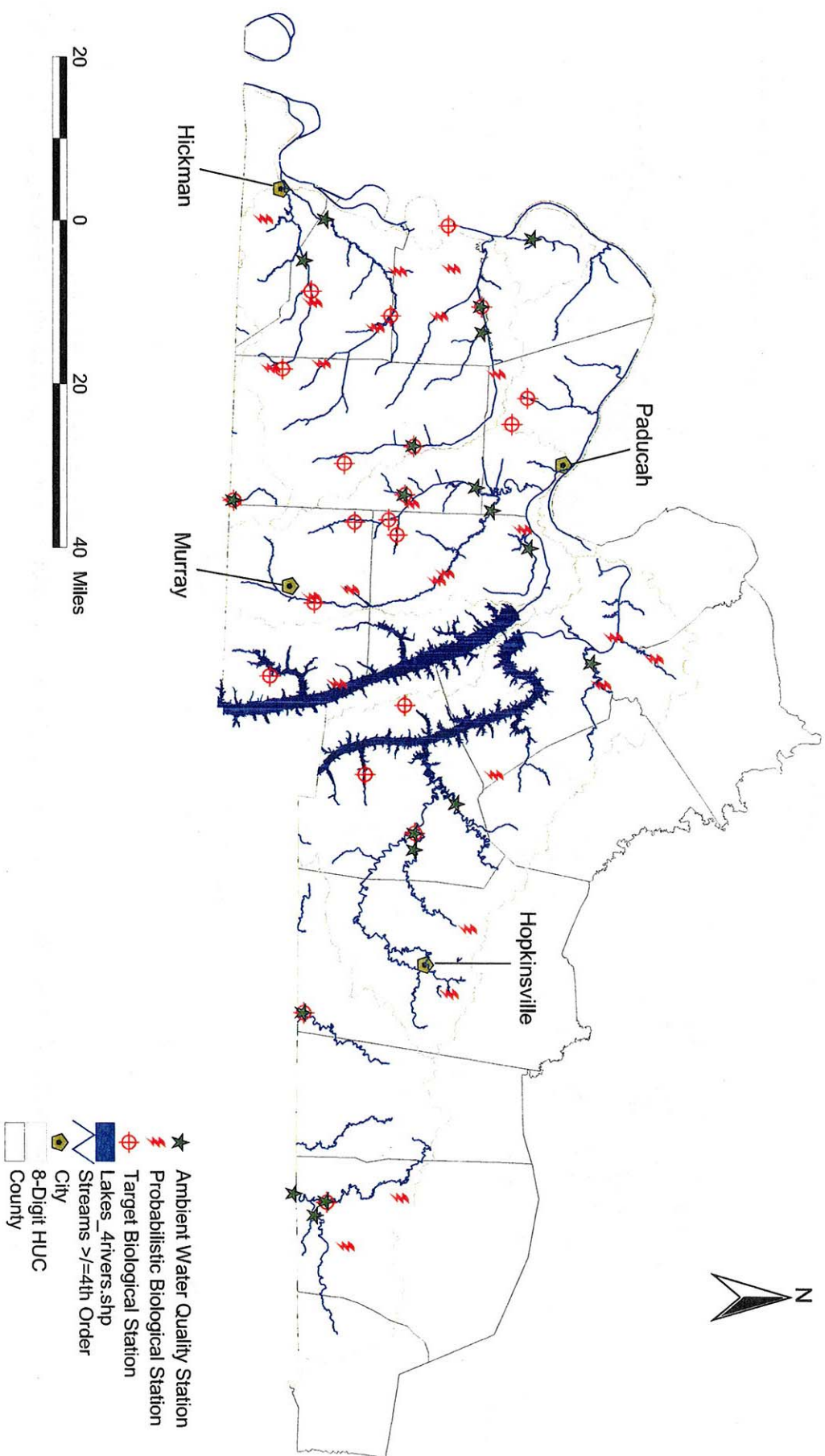
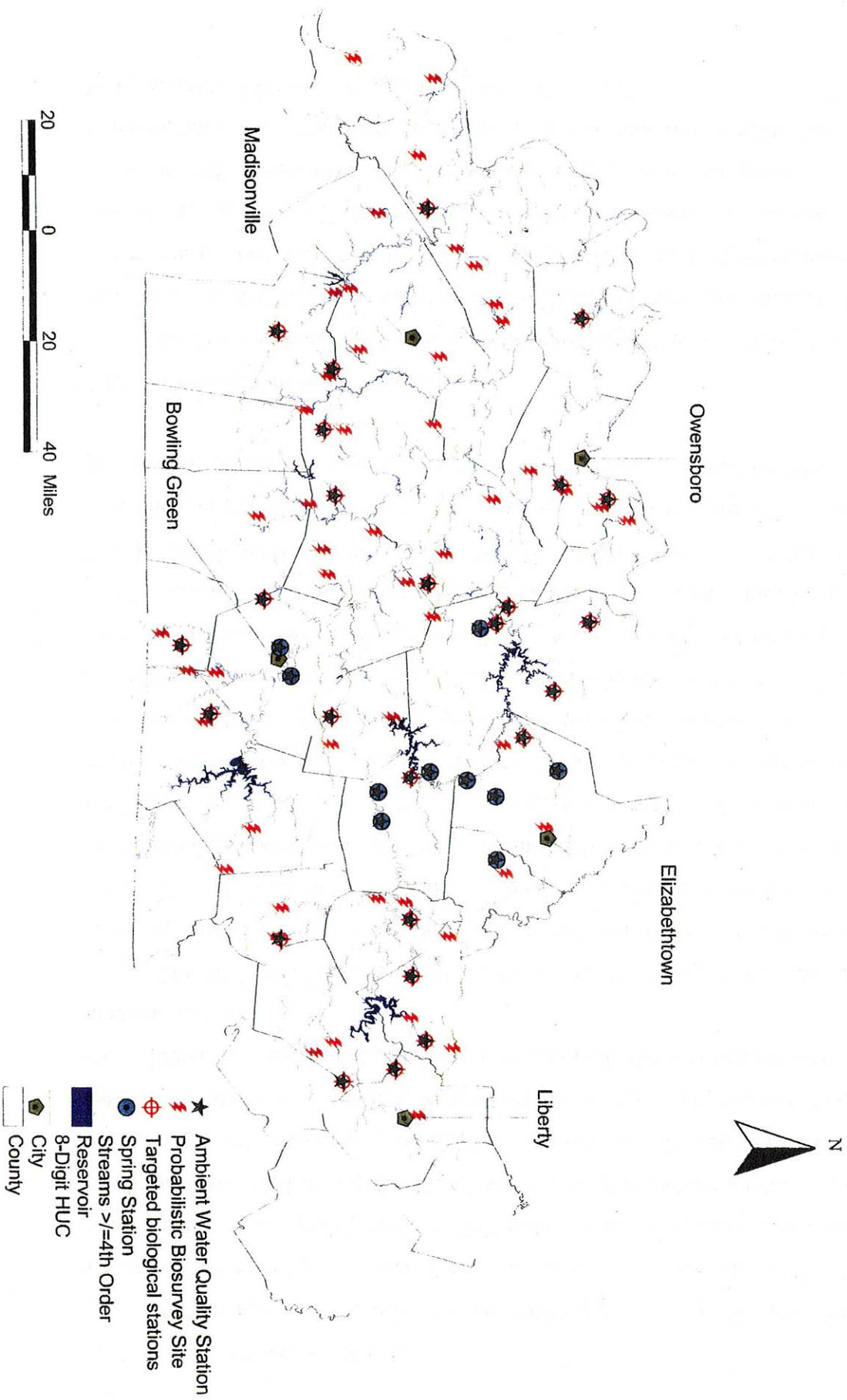




Figure 3.1.1-4. Targeted biological (including probabilistic sites) and ambient water quality monitoring stations in Green - Tradewater BMU.



### 3.1.2 Rotating Watershed Network

An interagency monitoring team established several objectives for the one-year watershed water quality monitoring stations. The objectives were to: 1) obtain an overall representation of the quality of the basin's water resources; 2) determine water quality conditions associated with major land cover or land uses such as forest, urban, agriculture and mining; 3) characterize the basin's least impacted waters; and 4) collect data for establishing total maximum daily loads (TMDLs) as required by Section 303(d) of the Clean Water Act. Parameters analyzed were similar to those described earlier for the ambient network.

The Division of Environmental Services, the laboratory of the Kentucky Environmental and Public Protection Cabinet, analyzed water quality samples collected by KDOW. The rotating watershed water quality monitoring network consisted of 16 stations in the upper Cumberland River basin and 14 stations in the 4-Rivers basin (Tables 3.1.2-1; 3.1.2-2; and 3.1.2-3). The Green – Tradewater BMU had 30 rotating water quality stations. Rotating stations were typically located at the downstream reaches of USGS 11-digit watersheds; however, some streams with particular issue of concern were monitored in this network for that singular reason (Figures 3.1.2-1; 3.1.2-2; and 3.1.2-3). Monthly sampling was conducted over the 12-month watershed monitoring period April 2005 – March 2006 in the Upper Cumberland and 4-Rivers BMU and April 2006 – March 2007 in the Green - Tradewater BMU to characterize water quality of each watershed represented. The KDOW follows water quality sample collection and preservation procedures found in its water quality monitoring SOP (2005).

### 3.1.3 Swimming Advisory Monitoring

KDOW continued to sample areas with long-standing swimming advisories in three basins in 2007: 10 sites in the upper Cumberland River basin on seven streams, 18 watersheds or sites in the Northern Kentucky area (lower Licking River basin) and four sites on the North Fork Kentucky River basin from Chavies to headwaters.

In 2007 the KDOW began monitoring large reservoirs for pathogen indicator (*Escherichia coli*). This effort will result in 12 reservoirs, mostly COE dam projects, being monitored for PCR at significant recreation areas.

Table 3.1.2-1. Rotating watershed water quality stations.

<u>Site ID</u>	<u>Stream</u>	<u>Latitude</u>	<u>Longitude</u>	<u>Mile Point</u>	<u>Description</u>
<b>Upper Cumberland River Basin</b> (April 2005 – March 2006)					
CRW008	Marrowbone Creek	36.78639	-85.42019	1.2	nr Leslie
CRW009	Croccus Creek	36.86561	-85.33877	2.4	nr Bakertown
CRW010	Roundstone Creek	37.33535	-84.23246	0.5	nr Livingston
CRW011	Middle Fork Rockcastle R.	37.34381	-84.08069	4.6	nr Parrot
CRW012	South Fork Rockcastle R.	37.29631	-84.09319	5.3	nr Cornette
CRW014	Laurel River	37.042	-84.04831	31.3	nr Lily
CRW015	Marsh Creek	36.74389	-84.371	7.2	nr Sand Hill
CRW016	Jellico Creek	36.74549	-84.26594	5.4	nr Duckrun
CRW017	Richland Creek	36.86901	-83.89800	1.8	nr Barbourville
CRW018	Straight Creek	36.7735	-83.66989	0.2	nr Straight Cr
CRW019	Yellow Creek	36.70981	-83.64492	1.0	nr Ponza
CRW020	Poor Fork Cumberland River	36.89331	-83.26561	5.4	at Rosspoint
CRW021	Clover Fork Cumberland River	36.861	-83.29181	1.9	at Golden Ash
CRW022	Martins Fork	36.84720	-83.32554	2.8	nr Harlan
CRW023	Pitman Creek	37.04573	-84.57631	5.95	at Cabin Hollow Brdg



Table 3.1.2-1 (cont.). Rotating watershed water quality stations.

<u>Site ID</u>	<u>Stream</u>	<u>Latitude</u>	<u>Longitude</u>	<u>Mile Point</u>	<u>Description</u>
<b>Upper Cumberland River Basin</b> (April 2005 – March 2006, cont.)					
CRW024	Pitman Creek	37.04391	-84.59591	7.0	at Somerset STP

Figure 3.1.2-1. Upper Cumberland River basin rotating watershed water quality stations monitored 2005-6.

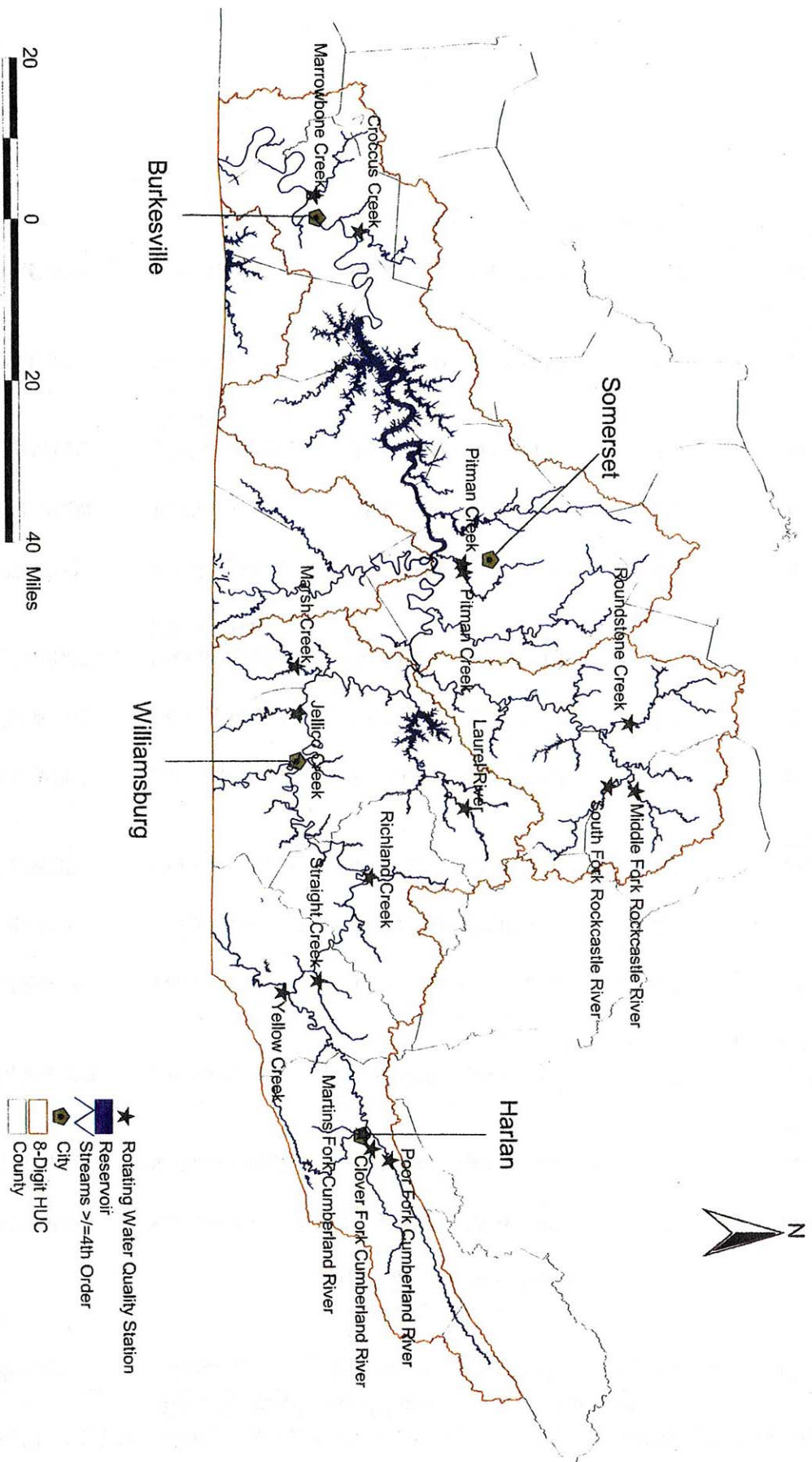




Table 3.1.2-2. Rotating watershed water quality stations in 4-Rivers (lower Cumberland, Mississippi, Ohio and Tennessee rivers) basins.

<u>Site ID</u>	<u>Stream</u>	<u>Latitude</u>	<u>Longitude</u>	<u>Mile Point</u>	<u>Description</u>
<b>4-Rivers Basin</b> (April 2005 – March 2006)					
MRW001	Mayfield Creek	36.81889	-88.63039	38.6	nr Hickory
MRW002	Wilson Creek	36.93381	-88.88581	0.7	nr Cunningham
MRW003	Obion Creek	36.64939	-89.12261	8.7	at Waynes Corner
MRW004	Terrapin Creek	36.50866	-88.49890	3.4	nr Bell City
ORW001	Shawnee Creek	37.01519	-89.09711	2.7	nr Wickliffe
TRW001	Cypress Creek	37.02939	-88.52219	3.1	nr Calvert City
TRW002	Panther Creek	36.80556	-88.52219	1.3	nr Hicksville
CRW001	Livingston Cr	37.14311	-88.1635	5.8	nr Dycusburg
CRW002	Muddy Fork Little River	36.91389	-87.84419	5.7	nr Cadiz
CRW003	Sinking Fork	36.84069	-87.74081	4.1	nr Cadiz
CRW004	W Fk Red R.	36.65161	-87.37769	16.1	nr Oak
CRW005	Whippoorwill Creek	36.69690	-86.96334	4.5	nr Dot
RED001	Red River	36.67819	-86.93212	57.4	at Logan Mill Road
RED002	S Fk Red R.	36.66722	-86.89700	2.6	at Barrens Plain Road

Figure 3.1.2-2. 4-Rivers rotating water quality stations monitored 2005-6.

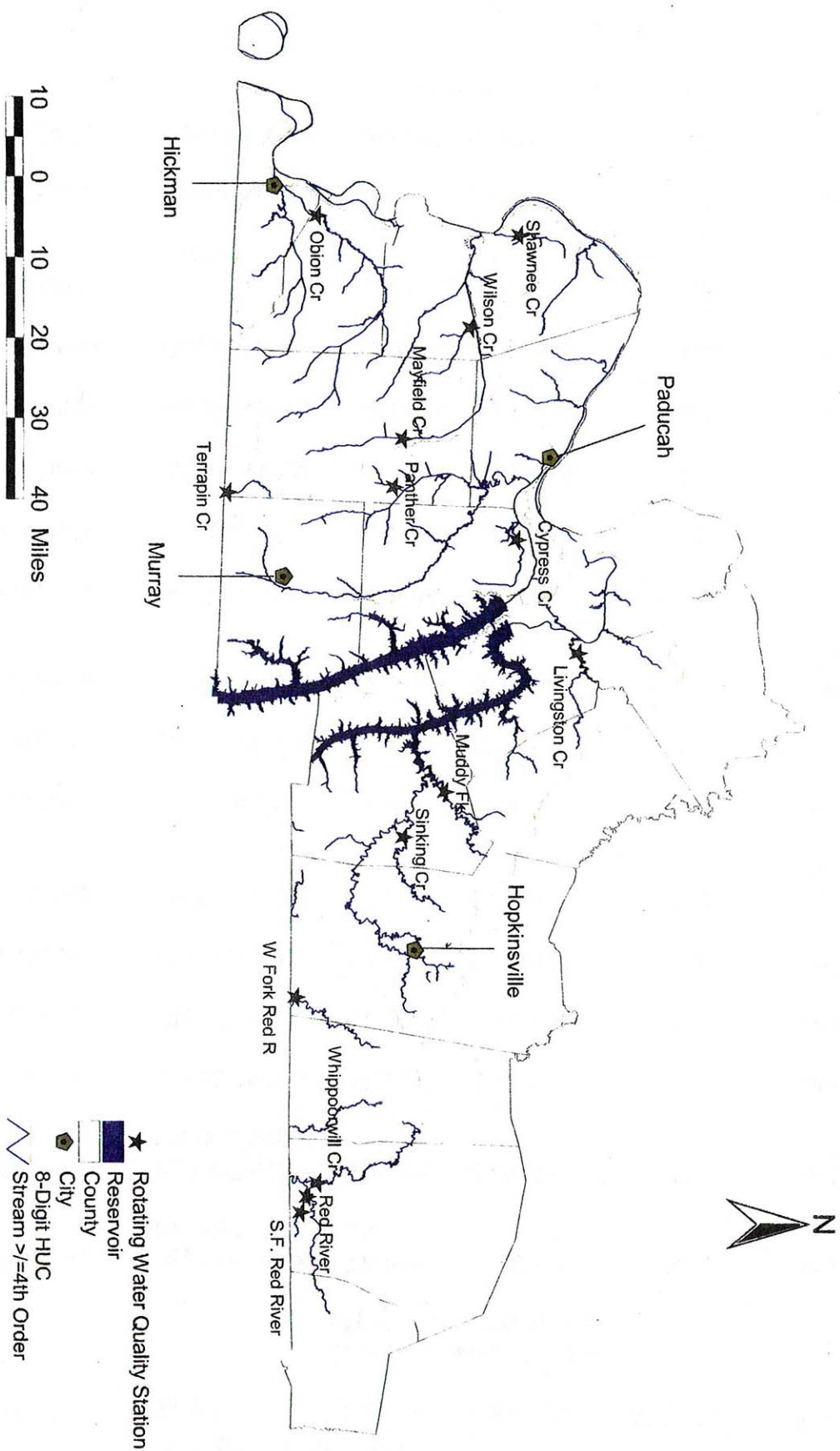


Table 3.1.2-3. Rotating watershed water quality stations, Green – Tradewater Basin Management Unit (cont.).

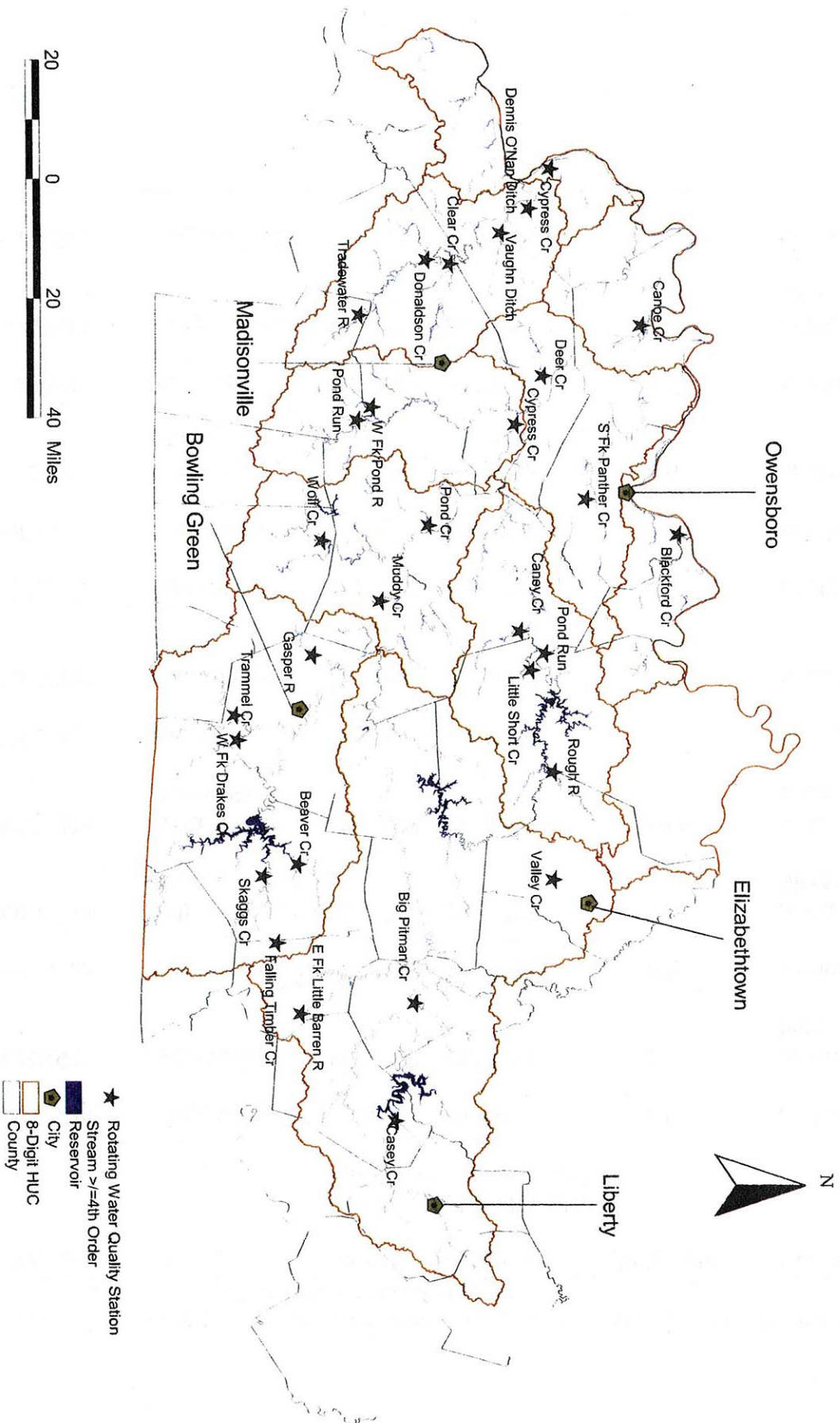
<u>Site ID</u>	<u>Stream</u>	<u>Latitude</u>	<u>Longitude</u>	<u>Mile Point</u>	<u>Description</u>
<b>Green – Tradewater BMU</b> (April 2006 – March 2007)					
GRN001	Cypress Creek/ Dennis O’Nan Ditch	37.57910	-88.09751	2.1	nr Dakoven
GRN002	Relict Cypress Creek Channel	37.5304	-87.9751	2.2	nr Sturgis
GRN003	Vaughn Ditch	37.46343	-87.89834	2.3	nr Derby
GRN004	Clear Creek	37.3425	-87.8003	1.5	nr Providence
GRN005	Donaldson Cr.	37.284	-87.8103	2.3	nr Fryer
GRN006	Tradewater R.	37.123	-87.6392	104.0	nr Dawson Springs
GRN012	Deer Creek	37.573	-87.46500	3.1	Onton
GRN013	Cypress Creek	37.50908	-87.31656	3.3	nr Rumsey
GRN014	W. Fk. Pond R.	37.157	-87.3598	2.2	nr Mount Carmel
GRN017	Pond Creek	37.30068	-87.00449	1.8	nr Martwick
GRN028	Pond River	37.12222	-87.31946	60.5	nr Apex
GRN018	Wolf Lick Cr.	37.0416	-86.95414	4.2	nr Dunmore
GRN019	Muddy Creek	37.18390	-86.77307	5.2	nr Dunbar
GRN020	Gasper River	37.02207	-86.60702	12.2	nr Hadley
GRN021	W. Fk. Drakes Creek	36.83858	-86.42451	1.2	nr Boyce
GRN022	Trammel Creek	36.845	-86.3494	5.5	nr Allen Spgs
GRN023	Beaver Creek	36.9898	-85.9754	3.2	nr Glasgow



Table 3.1.2-3 (cont.). Rotating watershed water quality stations, Green – Tradewater Basin Management Unit (cont.).

<u>Site ID</u>	<u>Stream</u>	<u>Latitude</u>	<u>Longitude</u>	<u>Mile Point</u>	<u>Description</u>
<b>Green – Tradewater BMU</b> (April 2006 – March 2007)					
GRN024	Skaggs Creek	36.9073	-85.939	5.9	nr Roseville
GRN025	Big Pitman Cr.	37.27303	-85.55374	3.1	nr Greens- burg
GRN026	Casey Creek	37.22388	-85.19682	0.8	Knifely
GRN029	Falling Timber Creek	36.93916	-85.73713	11.3	nr Summer Shade
GRN030	E. Fk. Little Barren River	36.99604	-85.52349	19.6	at Mosby Ridge Rd
GRN011	Blackford Cr.	37.89885	-86.98628	3.7	nr Maceo
GRN009	S. Fk. Panther Creek	37.6794	-87.09078	1.7	nr Sutherland
GRN007	Canoe Creek	37.802	-87.6247	3.5	nr Henderson
GRN015	Caney Creek	37.52621	-88.68663	1.85	nr Olaton
GRN031	Little Short Creek	37.55447	-86.56852	0.6	at SR 736
GRN032	Pond Run	37.58713	-86.6201	2.7	nr Shreve
GRN016	Rough River	37.6098	-86.2588	129.9	at Hardin Springs
GRN027	Valley Creek	37.61141	-85.93063	2.2	nr Glendale

Figure 3.1.2-3. Green-Tradewater BMU rotating watershed water quality stations monitored 2006-7.



### 3.1.4 Biomonitoring and Biosurvey Programs

**Introduction.** There are four biological monitoring programs within KDOW. Those programs have the same primary purpose of assessing the aquatic life use support of streams in the commonwealth. Although each program is driven by broad objectives, together they provide a comprehensive program that addresses aquatic life use attainment from several approaches: 1) random, overall snapshot of the ambient conditions; 2) the integration of conditions in relatively large watersheds monitored for long-term trend evaluation; 3) impact assessments related to nonpoint source pollution; 4) impact assessments related to point source pollution; and 5) a regional reference program to assess least impacted streams for development and refinement of metric benchmarks used to assess lotic ecosystems.

**Reference Reach Program.** In 1991, KDOW began a Reference Reach (RR) program to gather data from the state's least impacted streams. Biologists first identified potential least impacted waters representative of Level-III Ecoregions. Then, data on physicochemical water quality, sediment quality, fish tissue residue, habitat condition, and biotic conditions were collected to define the potential environmental quality for the streams of a particular ecoregion; this to provide a baseline to compare other streams in the same ecoregion to those reference conditions. Data from the reference reach program provided the basis for the development of narrative and numerical biocriteria for the various ecoregions of the commonwealth; results indicated multimetric indices could be developed resulting in four bioregions. Fifty-five stream sites from seven Level-III Ecoregions were initially sampled in the spring and fall of 1992-1993. Since that time, many additional potential reference reach streams were sampled. Some were adopted as reference reach streams; others were rejected because they did not possess adequate quality to represent least impacted condition. Currently, 150 RR streams totaling approximately 1,102 miles are identified throughout the commonwealth (Table 3.1.4-1). Forty-four (141.7 miles) candidate exceptional or reference reach streams, or segments, are proposed for inclusion in 401 KAR 5:030 during the triennial review submission, 2008 (Table 3.1.4-2).



Table 3.1.4-1. Reference reach streams in Kentucky with those in bold to emphasize streams in the upper Cumberland – 4-Rivers and Green – Tradewater BMUs.

<u>Stream</u>	<u>County</u>	<u>Location</u>	<u>Basin</u>	<u>Start Segment</u>	<u>End Segment</u>	<u>Total Miles</u>
Hobbs Fork	Martin	Mouth to headwaters	Big Sandy	3.8	0.0	3.8
Hobbs Fork, UT	Martin	Hobbs Fork to headwaters	Big Sandy	0.55	0.0	0.55
Lower Pigeon Branch	Pike	Left Fork to headwaters	Big Sandy	1.7	0.5	1.2
Russell Fork	Pike	Clinch Field RR Yd off SR 80 to Kentucky – Virginia state line	Big Sandy	16.0	14.4	1.6
Toms Branch	Pike	Mouth to headwaters	Big Sandy	1.4	0.1	1.3
<b>Cane Creek</b>	<b>Whitley</b>	<b>0.1 mi below Daylight Branch</b>	<b>Upper Cumberland</b>	<b>11.5</b>	<b>7.0</b>	<b>4.5</b>
<b>Bark Camp Creek</b>	<b>Whitley</b>	<b>U.S. Forest Service Rd 193 bridge</b>	<b>Upper Cumberland</b>	<b>7.6</b>	<b>2.6</b>	<b>5</b>
<b>Bad Branch</b>	<b>Letcher</b>	<b>0.2 mi above KY 932 bridge</b>	<b>Upper Cumberland</b>	<b>3.0</b>	<b>0.0</b>	<b>3</b>
Beaver Creek	McCreary	Mouth to Freeman and Middle forks	Upper Cumberland	6.5	0.0	6.5
Brownies Creek	Bell, Harlan	Blacksnake Branch to headwaters	Upper Cumberland	16.0	9.0	7.0
Brushy Creek	Pulaski	Mouth to headwaters	Upper Cumberland	16.0	0.0	16.0
Buck Creek	Pulaski	Off Bud Rainey Rd	Upper Cumberland	62.6	28.9	33.7
Bunches Creek	Whitley	Mouth to headwaters	Upper Cumberland	3.3	0.0	3.3
Cogur Fork	McCreary	Mouth to headwaters	Upper Cumberland	7.9	0.0	7.9
Dog Slaughter Creek	Whitley	Mouth to North and South forks	Upper Cumberland	1.1	0.0	1.1
Eagle Creek	McCreary	KY 896 bridge	Upper Cumberland	6.3	3	3.3
Fugitt Creek	Harlan	Land use change to headwaters	Upper Cumberland	4.9	0.5	4.4
South Fork Dog Slaughter Creek	Whitley	1000 ft above foot bridge (Dog Slaughter Falls Trail)	Upper Cumberland	4.6	0.0	4.6
Marsh Creek	McCreary	Laurel Creek to headwaters	Upper Cumberland	26.2	8.6	17.8
Horse Lick Creek	Jackson	Mouth to Clover Bottom	Upper Cumberland	12.3	0.0	12.3
Indian Creek	McCreary	Laurel Fork to Barren Fork	Upper Cumberland	6.7	2.3	4.4
Howards Creek	Clinton	Dale Hollow Lake backwaters to headwaters	Upper Cumberland	3.4	0.8	2.6
Jackie Branch	Whitley	Mouth to headwaters	Upper Cumberland	1.7	0.0	1.7
Laurel Fork of Clear Fork	Whitley	Tennessee state line to Tiny Branch/Pine Creek	Upper Cumberland	13.0	4.2	8.8
Laurel Fork of Middle Fork Rockcastle River	Jackson	Mouth to headwaters	Upper Cumberland	12.2	0.0	12.2
Little South Fork Cumberland River	McCreary/ Wayne	River mile 35.5 to river mile 14.5	Upper Cumberland	14.5	4.1	10.4
Little South Fork Cumberland River	McCreary/ Wayne	Mouth to Lanham Branch	Upper Cumberland	35.6	0.0	35.6

Table 3.1.4-1 (cont.). Reference reach streams in Kentucky with those in bold to emphasize those in streams upper Cumberland – 4-Rivers and Green – Tradewater BMUs.

<u>Stream</u>	<u>County</u>	<u>Location</u>	<u>Basin</u>	<u>Start Segment</u>	<u>End Segment</u>	<u>Total Miles</u>
Middle Fork Rockcastle River	Jackson	Mouth to Horselick Creek	Upper Cumberland	7.8	0.0	7.8
Mud Camp Creek	Monroe/ Cumberland	UT to headwaters	Upper Cumberland	8.4	3.7	4.7
Mud Camp Creek	Cumberland	Mouth to Collins Branch	Upper Cumberland	1.3	0.0	1.3
Poor Fork Cumberland River	Letcher	Franks Creek to headwaters	Upper Cumberland	51.7	46.1	5.6
Presley House Branch	Letcher	Mouth to headwaters	Upper Cumberland	1.5	0.0	1.5
Puncheoncamp Branch	McCreary	Mouth to headwaters	Upper Cumberland	1.9	0/0	1.9
Rock Creek	McCreary	Kentucky – Tennessee state line (river mile 21.9 to White Oak Cr.	Upper Cumberland	21.5	3.9	17.8
Rock Creek, unidentified tributary	McCreary	Mouth to headwaters	Upper Cumberland	1.9	0.0	1.9
Rock Creek, unidentified tributary	McCreary	Mouth to headwaters	Upper Cumberland	1.15	0.0	1.15
Shilalah Creek	Bell	River mile 5.5 to Clear Fork Yellow Creek	Upper Cumberland	5.5	0.0	5.5
Sinking Creek	Laurel	Mouth to White Oak Creek	Upper Cumberland	9.8	0.0	9.8
South Fork Dog Slaughter Creek	Whitley	Basin to Dog Slaughter Creek	Upper Cumberland	4.6	0.0	4.6
Sulphur Creek	Clinton	Dale Hollow Lake backwaters to headwaters	Upper Cumberland	5.1	1.7	3.4
Watts Branch	McCreary	Mouth to headwaters	Upper Cumberland	2.6	0.0	2.6
Watts Creek	Harlan	Basin above Camp Blanton Lake (river mile 4.3) to river mile 2.2	Upper Cumberland	4.3	2.2	2.1
Beaverdam Creek	Edmonson	KY 101-259 bridge	Green	14.0	7.6	6.4
Cane Run	Hart	River mile 6.5 to river mile 1.0	Green	6.5	1.0	5.5
Trammel Fork	Allen	Mouth to KY – TN state line	Green	30.15	0.0	30.15
Lick Creek	Simpson	Mouth to headwaters	Green	9.9	0.0	9.9
Peter Creek	Barren	Candy Fork to Dry Fork	Green	18.5	11.6	7.9
Caney Fork	Barren	Source to river mile 0.85	Green	6.6	0.0	6.6
Clifty Creek	Todd	Little Clifty Creek to Sulphur Lick	Green	13.2	7.7	5.5
Clifty Creek	Grayson	Barton Runt to Western KY Pkwy	Green	17.2	7.3	9.9
E. Fork Little Barren River	Metcalfe	Red Lick Creek to Flat Lick Creek	Green	20.2	19/0	1.2
Elk Lick C						
Falling Timber Creek	Metcalfe	Land use change to headwaters	Green	15.5	7.0	8.5
Fiddlers Creek	Breckinridge	Mouth to headwaters	Green	5.8	0.0	5.8
Forbes Creek	Christian	Mouth to UT	Green	3.9	0.0	3.9
Gasper River	Logan	Clear Fork to Wiggington Creek	Green	35.2	17.0	18.2
Goose Creek	Casey, Russell	Mouth to Little Goose Creek	Green	8.1	0.0	8.1
Green River, UT	Adair	Land use change to headwaters	Green	3.2	0.8	2.4
Halls Creek	Ohio	UT to headwaters	Green	12.1	9.6	2.5
Linders Creek	Hardin	Mouth to Sutzer Creek	Green	7.7	0.0	7.7
Little Short Creek	Grayson	Mouth to headwaters	Green	3.0	0.0	3.0



Table 3.1.4-1 (cont.). Reference reach streams in Kentucky with those in bold to emphasize those in streams upper Cumberland – 4-Rivers and Green – Tradewater BMUs

<u>Stream</u>	<u>County</u>	<u>Location</u>	<u>Basin</u>	<u>Start Segment</u>	<u>End Segment</u>	<u>Total Miles</u>
Lynn Camp Creek	Hart	Mouth to Lindy Creek	Green	8.3	0.0	8.3
McFarland Creek	Christian, Hopkins	Grays Branch to UT	Green	4.8	1.4	3.4
Meeting Creek	Hardin	Little Meeting Cr to Petty Branch	Green	13.8	5.2	8.3
Muddy Creek	Ohio	Land use change to headwaters	Green	15.5	13.0	2.5
North Fork Rough River	Breckinridge	Buffalo Creek to Reservoir dam	Green	28.1	23.44	4.66
Pond Run	Breckinridge, Ohio	Lane use change to headwaters	Green	6.8	1.4	5.4
Rough River	Hardin	Linders Creek to Vertrees Creek	Green	147.8	136.9	10.9
Russell Creek	Adair, Russell	Mouth to headwaters	Green	68.1	0.0	68.1
Sixes Creek	Ohio	Wild Branch to headwaters	Green	7.5	2.0	5.5
Sulphur Branch	Edmonson	Mouth to headwaters	Green	2.0	0.0	2.0
W. Fork Pond River	Christian	UT to East Branch Pond River	Green	22.5	12.7	9.8
UT, White Oak Creek	Adair	Hovious Road Crossing to SR 76	Green	3.0	0.4	2.6
Goose Creek	Casey	Off Brock Rd	Green	14.6	5.6	9.0
Drennon Creek	Henry	Flat Bottom Rd crossing	Kentucky	10.5	11.9	1.4
Indian Creek	Carroll	Hwy 36 bridge	Kentucky	0.55	4.7	4.15
Musselman Creek	Grant	Lawrenceville – Keefer Rd bridge	Kentucky	2.6	8.4	5.8
Clear Creek	Woodford	Hifner Rd bridge, 2.1 mi S of Mortonsville	Kentucky	4.1	19.0	14.9
Station Camp Creek	Estill	Off KY Hwy 1209 at Estill-Jackson County boundary	Kentucky	19.0	22.3	3.3
South Fork Station Camp Creek	Jackson	KY 89 bridge	Kentucky	5.3	48.6	43.3
Sturgeon Creek	Lee	Off Sturgeon Creek Rd	Kentucky	4.0	31.1	27.3
*Sulphur Creek	Franklin	Mouth to headwaters	Kentucky	0.0	5.2	5.2
Gladie Creek	Menifee	0.2 mi upstream of bridge	Kentucky	0.0	8.4	8.4
East Fork Indian Creek	Menifee	1 mi upstream of West Fork Indian Cr	Kentucky	0.0	8.5	8.5
Wolfpen Branch	Menifee	at SR 715 bridge	Kentucky	0.0	3.3	3.3
Right Fork Buffalo Creek	Owsley	Off Whoopflarea Rd	Kentucky	0.0	11.2	11.2
Buffalo Creek	Owsley	Side road along mainstem	Kentucky	0.8	12.8	12.0
Coles Fork	Breathitt	in Robinson Forest	Kentucky	0.0	5.5	5.5
*Craig Creek	Leslie	Mouth to UT	Kentucky	0.0	2.7	2.7
Elisha Creek	Leslie	Elisha Creek Road	Kentucky	0.95	3.3	2.35
Line Fork Creek	Letcher	off KY 160	Kentucky	17.3	27.5	10.2
*Rock Lick Creek	Jackson	Mouth to headwaters	Kentucky	0.0	9.6	9.6
Blackwater Creek	Morgan	Eaton Creek to Greasy Creek	Licking	3.8	11.4	7.6
Brushy Fork	Pendleton	Mouth to headwaters	Licking	0.0	5.7	5.7
North Fork Licking River	Morgan	Cave Run L. backwaters to Devils Fk	Licking	14.2	9.9	4.3
Bucket Branch	Morgan	Leisure – Paragon Rd bridge	Licking	0.0	1.9	1.9
Devils Fork	Morgan	KY 711 bridge	Licking	0.0	7.8	7.8
Grovers Creek	Pendleton	Kincaid L. backwaters to UT	Licking	3.4	0.5	2.9
Big Sinking Creek	Carter	KY 986 bridge	Little Sandy	15.2	10.7	4.5
Arabs Fork	Elliott	KY 1620 bridge	Little Sandy	4.7	0.0	4.7
Big Caney Creek	Elliott	Grayson L. backwaters to headwaters	Little Sandy	14.9	0.0	14.9
Big Sinking Creek	Carter, Elliott	SR 986 to Clay and Arab forks	Little Sandy	15.2	10.7	4.5
Laurel Creek	Elliott	Carter School Rd Bridge	Little Sandy	14.4	7.6	6.8



Table 3.1.4-1 (cont.). Reference reach streams in Kentucky with those in bold to emphasize those in streams upper Cumberland – 4-Rivers and Green – Tradewater BMUs

<u>Stream</u>	<u>County</u>	<u>Location</u>	<u>Basin</u>	<u>Start Segment</u>	<u>End Segment</u>	<u>Total Miles</u>
Meadow Branch	Elliott	Mouth to headwaters	Little Sandy	1.4	0.0	1.4
Middle Fork Little Sandy R.	Elliott	Mouth to Sheepskin Branch	Little Sandy	3.6	0.0	3.6
Nichols Creek	Elliott	Green Branch to headwaters	Little Sandy	1.9	0.0	1.9
<b>Jackson Creek</b>	<b>Graves</b>	<b>Basin</b>	<b>Mississippi</b>	<b>2.6</b>	<b>0.0</b>	<b>2.6</b>
<b>Obion Creek</b>	<b>Hickman</b>	<b>Hurricane Creek to Little Creek</b>	<b>Mississippi</b>	<b>35.5</b>	<b>25.2</b>	<b>10.3</b>
<b>Big Sugar Creek</b>	<b>Gallatin</b>	<b>I-71 to headwaters</b>	<b>Ohio</b>	<b>3.6</b>	<b>1.0</b>	<b>3.6</b>
<b>Corn Creek, UT</b>	<b>Trimble</b>	<b>Mouth to headwaters</b>	<b>Ohio</b>	<b>2.0</b>	<b>0.0</b>	<b>2.0</b>
<b>Crooked Creek</b>	<b>Crittenden</b>	<b>Rush Creek to City Lake Dam</b>	<b>Ohio</b>	<b>25.6</b>	<b>17.5</b>	<b>8.1</b>
<b>Double Lick Creek</b>	<b>Boone</b>	<b>Mouth to land use change</b>	<b>Ohio</b>	<b>1.4</b>	<b>0.0</b>	<b>1.4</b>
<b>Garrison Creek</b>	<b>Boone</b>	<b>Mouth to headwaters</b>	<b>Ohio</b>	<b>4.1</b>	<b>0.0</b>	<b>4.1</b>
<b>Kinniconick Creek</b>	<b>Lewis</b>	<b>McDowell Creek to headwaters</b>	<b>Ohio</b>	<b>50.4</b>	<b>5.1</b>	<b>45.3</b>
<b>Massac Creek</b>	<b>McCracken</b>	<b>Mouth to headwaters</b>	<b>Ohio</b>	<b>1.7</b>	<b>0.0</b>	<b>1.7</b>
<b>Middle Fork Massac Creek</b>	<b>McCracken</b>	<b>Hines Road to headwaters</b>	<b>Ohio</b>	<b>6.2</b>	<b>3.15</b>	<b>3.05</b>
<b>Second Creek</b>	<b>Boone</b>	<b>Private road crossing to headwaters</b>	<b>Ohio</b>	<b>2.9</b>	<b>0.5</b>	<b>2.4</b>
<b>W. Fork Massac Creek</b>	<b>McCracken</b>	<b>River mile 5.4 to river mile 3.2</b>	<b>Ohio</b>	<b>5.4</b>	<b>3.2</b>	<b>2.2</b>
<b>Yellowbank Creek</b>	<b>Breckinridge</b>	<b>Ohio River backwaters to headwaters</b>	<b>Ohio</b>	<b>11.4</b>	<b>1.4</b>	<b>10.0</b>
<b>Yellowbank Creek</b>	<b>Breckinridge</b>	<b>Cart-Manning Crossing Rd Wildlife Management Area</b>	<b>Ohio</b>	<b>11.9</b>	<b>4.4</b>	<b>7.5</b>
<b>Grindstone Creek</b>	<b>Calloway</b>	<b>Mouth to headwaters</b>	<b>Tennessee</b>	<b>2.3</b>	<b>0.0</b>	<b>2.3</b>
<b>Soldier Creek</b>	<b>Marshall</b>	<b>HWY 58 bridge</b>	<b>Tennessee</b>	<b>5.3</b>	<b>2.6</b>	<b>2.7</b>
<b>Panther Creek</b>	<b>Calloway</b>	<b>KY 280 bridge</b>	<b>Tennessee</b>	<b>6.0</b>	<b>0.0</b>	<b>6.0</b>
<b>Panther Creek, UT</b>	<b>Graves</b>	<b>Mouth to headwaters</b>	<b>Tennessee</b>	<b>2.1</b>	<b>0.0</b>	<b>2.1</b>
<b>Soldier Creek</b>	<b>Marshall</b>	<b>Mouth to South Fork Soldier Cr.</b>	<b>Tennessee</b>	<b>5.3</b>	<b>0.0</b>	<b>5.3</b>
<b>Trace Creek</b>	<b>Graves</b>	<b>Mouth to Neely Branch</b>	<b>Tennessee</b>	<b>3.0</b>	<b>0.0</b>	<b>3.0</b>
<b>W. Fork Clarks River</b>	<b>Graves/ Marshall</b>	<b>Soldier Creek to Duncan Creek</b>	<b>Tennessee</b>	<b>22.7</b>	<b>19.7</b>	<b>3.0</b>
<b>Wildcat Creek</b>	<b>Calloway</b>	<b>Ralph Wright Road crossing to headwaters</b>	<b>Tennessee</b>	<b>6.7</b>	<b>3.5</b>	<b>3.2</b>
<b>Blood River</b>	<b>Calloway</b>	<b>Grubbs Lane bridge; 0.75 mi E of State Line Rd</b>	<b>Tennessee</b>	<b>15.65</b>	<b>12.2</b>	<b>3.45</b>
<b>East Fork Flynn Fork</b>	<b>Caldwell</b>	<b>Land use change to headwaters</b>	<b>Tradewater</b>	<b>4.6</b>	<b>2.5</b>	<b>2.1</b>
<b>Piney Creek</b>	<b>Caldwell</b>	<b>L. Beshear backwaters to headwaters</b>	<b>Tradewater</b>	<b>10.2</b>	<b>4.5</b>	<b>5.7</b>
<b>Piney Creek, UT</b>	<b>Caldwell</b>	<b>Mouth to headwaters</b>	<b>Tradewater</b>	<b>0.0</b>	<b>2.9</b>	<b>2.9</b>
<b>Tradewater River</b>	<b>Christian, Hopkins</b>	<b>Dripping Springs Br to Buntin Lake dam</b>	<b>Tradewater</b>	<b>131.1</b>	<b>123.2</b>	<b>7.9</b>
<b>Sandlick Creek</b>	<b>Christian</b>	<b>Camp Creek to headwaters</b>	<b>Tradewater</b>	<b>9.0</b>	<b>4.9</b>	<b>4.1</b>
<b>Sandlick Creek, UT</b>	<b>Christian</b>	<b>Mouth to headwaters</b>	<b>Tradewater</b>	<b>1.4</b>	<b>0.0</b>	<b>1.4</b>
<b>Cedar Creek</b>	<b>Bullitt</b>	<b>Mouth to Greens Branch</b>	<b>Salt</b>	<b>5.1</b>	<b>0.0</b>	<b>5.1</b>
<b>Chaplin River</b>	<b>Washington</b>	<b>Thompson Creek to Cornishville</b>	<b>Salt</b>	<b>53.7</b>	<b>40.1</b>	<b>13.6</b>
<b>Harts Run</b>	<b>Bullitt</b>	<b>Mouth to headwaters</b>	<b>Salt</b>	<b>2.3</b>	<b>0.0</b>	<b>2.3</b>
<b>Wilson Creek</b>	<b>Bullitt</b>	<b>Mt. Carmel Church Rd, first crossing</b>	<b>Salt</b>	<b>17</b>	<b>12.2</b>	<b>4.8</b>
<b>Salt Lick Creek</b>	<b>Marion</b>	<b>Mouth to headwaters</b>	<b>Salt</b>	<b>8.4</b>	<b>0.0</b>	<b>8.4</b>
<b>Sulphur Creek</b>	<b>Anderson</b>	<b>Mouth to Cheese Lick and Brush Cr</b>	<b>Salt</b>	<b>9.7</b>	<b>0.0</b>	<b>9.7</b>
<b>Otter Creek</b>	<b>Larue</b>	<b>0.1 mi below West Fork, Herbert-Howell Rd</b>	<b>Salt</b>	<b>2.7</b>	<b>1.7</b>	<b>1.0</b>
<b>Overalls Creek</b>	<b>Bullitt</b>	<b>Mouth to headwaters</b>	<b>Salt</b>	<b>1.3</b>	<b>0.0</b>	<b>1.3</b>
<b>West Fork Otter Creek</b>	<b>Larue</b>	<b>Mouth to headwaters</b>	<b>Salt</b>	<b>4.7</b>	<b>0.0</b>	<b>4.7</b>

Wilson Creek	Bullitt, Nelson	Mouth to headwaters	Salt	17.0	0.0	17.0
Table 3.1.4-1 (cont.). Reference reach streams in Kentucky with those in bold to emphasize those in streams upper Cumberland – 4-Rivers and Green – Tradewater BMUs						
<u>Stream</u>	<u>County</u>	<u>Location</u>	<u>Basin</u>	<u>Start Segment</u>	<u>End Segment</u>	<u>Total Miles</u>
Crooked Creek	Trigg	Lake Barkley backwaters to headwaters	Lower Cumberland	9.4	4.0	5.4
Donaldson Creek	Trigg	Craig Branch to UT	Lower Cumberland	10.3	6.9	3.4
Elk Fork	Todd	Kentucky – Kentucky stateline to Dry Branch	Lower Cumberland	9.8	7.5	2.3
Sugar Creek	Livingston	Lick Creek to UT	Lower Cumberland	6.7	2.1	4.6
West Fork Red River	Christian	Carter Rd bridge	Lower Cumberland	26.5	16.3	10.2
Whippoorwill Creek	Logan	Mouth to Vicks Branch	Lower Cumberland	13.0	0.0	13.0

<sup>a</sup>Candidate stream or segment included in the 2008 triennial review package

**Watershed Biological Monitoring Program (WBMP).** The WBMP monitored streams in a fixed-station network so long-term trends can be tracked in targeted fourth and fifth order watersheds (Figures 3.1.1-2; 3.1.1-3; and 3.1.1-4). Targeted stations were placed in the downstream reaches of fourth, fifth and occasionally sixth order (on 1:24,000 scale USGS topographic maps) watersheds. One reason for this choice was that the number of these watersheds closely matched the available monitoring resources. Another favorable attribute of this design was that these watersheds were more hydrologically accurate and uniform in size than 11-digit watersheds. A biosurvey was conducted at these stations which typically include two or three biological communities (macroinvertebrates, fishes, or diatoms) to determine the condition of wadeable streams. Also collected are nutrient samples (unionized ammonia, nitrite-nitrate, total phosphorus, and total Kjeldahl-nitrogen) in addition to bulk water quality variables (total suspended solids, chlorides, sulfates, alkalinity, hardness and total organic carbon). Physical measurements were also made at time of water quality sample collection; a multiparameter probe is used to measure pH, temperature, DO, percent DO saturation and specific conductance. Often, ambient water quality data were collected at these locations on a monthly basis during the BMU-cycle. These stations are revisited every five years.



Table 3.1.4-2. Candidate reference reach and exceptional streams and segments in the Kentucky as defined in 401 KAR 5:030.

<u>Basin</u>	<u>Stream</u>	<u>Segment Description</u>	<u>Segment Mile Points</u>	<u>Total Miles</u>	<u>Lat-Long (downstream)</u>	<u>Lat-Long (upstream)</u>	<u>County</u>	<u>Reference<sup>a</sup> or Exceptional<sup>b</sup></u>
Kentucky	Rock Lick Cr.	Mouth to Headwaters	0.0-9.6	9.6	37.53939 -84.01041	37.54762 -83.15038	Jackson	Reference
	Lower Howard Cr.	Mouth to West Fork	0.0-2.7	2.7	37.91802 -84.27256	37.93369 -84.26951	Clark	Exceptional
	Backbone Cr.	Mouth to Scrabble Cr.	0.0-1.7	1.7	38.33978 -84.99688	38.32024 -84.99354	Franklin, Henry, Shelby	Reference
	Sulphur Creek	Mouth to Headwaters	0.0-5.2	5.2	38.28752 -84.80238	38.30562 -84.74529	Franklin	Reference
	Craig Creek	Mouth to UT	0.0-2.7	2.7	37.97908 -84.8206	37.98133 -84.78473	Woodford	Reference
	Bear Branch	Above Sediment Pond to Headwaters	0.3-1.2	0.9	37.13216 -83.10139	37.12607 -83.11332	Perry	Exceptional
	Billey Fork	Land Use Change to Headwaters	2.6-8.8	6.2	37.6796 -83.7965	37.7254 -83.7250	Lee	Exceptional
	Cherry Run	Mouth to Boyd Run	0.0-0.9	0.9	38.21315 -84.48522	38.21726 -84.47431	Scott	Exceptional
	Gilberts Creek	Mouth to UT	0.0-2.6	2.6	37.97366 -84.81863	37.97570 -84.85231	Anderson	Exceptional
	Honey Branch	Mouth to Headwaters	0.0-1.4	1.4	37.01756 -83.35499	37.00966 -83.37233	Leslie	Exceptional
	Katies Creek	Mouth to Headwaters	0.0-4.0	4.0	37.0349 -83.5399	37.0177 -83.5964	Clay	Exceptional
	Little Middle Fk. Elisha Creek	Mouth Headwaters	0.0-0.75	0.75	37.08173 -83.51566	37.08750 -83.50586	Leslie	Exceptional
	*Middle Fk. Kentucky River	Hurts Creek to Greasy Creek	75.9-84.3	9.4	37.15529 -83.3704	37.07655 -83.39242	Leslie	Exceptional
	Right Fk. Elisha Cr.	Mouth to Headwaters	0.0-3.3	3.3	37.08165 -83.51802	37.07601 -83.46882	Leslie	Exceptional
Kentucky	Shaker Creek	Near Mouth to Shawnee Run	0.1-1.4	1.3	37.84727 -84.76563	37.84374 -84.76813	Mercer	Exceptional
	*Spruce Branch	Mouth to Headwaters	0.0-1.0	1.0	36.95706 -83.53100	36.94948 -83.51666	Clay	Exceptional



Table 3.1.4-2 (cont.). Candidate reference reach and exceptional streams and segments in Kentucky as defined in 401 KAR 5:030.

<u>Basin</u>	<u>Stream</u>	<u>Segment Description</u>	<u>Segment Mile Points</u>	<u>Total Miles</u>	<u>Lat-Long (downstream)</u>	<u>Lat-Long (upstream)</u>	<u>County</u>	<u>Reference<sup>a</sup> or Exceptional<sup>b</sup></u>
<u>Kentucky (cont.)</u>								
	Steeles Run	Mouth to UT	0.0-4.2	4.2	38.11101 -84.62885	38.06734 -84.59552	Fayette	Exceptional
	UT of Jacks Creek	Mouth to Headwaters	0.0-1.15	1.15	37.85200 -84.36529	37.85177 -84.34607	Madison	Exceptional
	UT of Kentucky R.	Near Mouth to Land Use Change	0.1-1.4	1.3	38.219102 -84.87777	38.23174 -84.8624	Franklin	Exceptional
	Billy Fork	Land use change to Headwaters	2.6-8.8	6.2	37.6796 -83.7965	37.7254 -83.7965	Lee, Estill	Exceptional
	Bill Oak Branch	Mouth to Headwaters	0.0	0.6	37.33551 -83.5671	37.33128 -83.55523	Scott	Exceptional
	Deep Ford Branch	Above Pond to Headwaters	0.3-1.3	1.0	37.19057 -83.34776	37.17650 -83.34856	Leslie	Exceptional
	Laurel Fork	Cortland Fork to Big Branch	2.1-3.8	1.7	37.34753 -83.56477	37.32790 -83.56767	Owsley	Exceptional
	Mikes Branch	Mouth to Headwaters	0.0-0.7	0.7	37.33903 -83.56345	37.33533 -83.55167	Owsley	Exceptional
	Watches Fork	Mouth to Headwaters	0.0-0.9	0.9	37.34461 -83.56242	37.34010 -83.54701	Owsley	Exceptional
	Licking	Mouth to UT	0.0-1.9	1.9	38.65566 -84.28532	38.64272 -84.29925	Pendleton	Exceptional
	Blanket Creek	Mouth to UT	0.0-1.9	1.9	38.65566 -84.28532	38.64272 -84.29925	Pendleton	Exceptional
	Bowman Creek	Mouth to UT	0.0-6.0	6.0	38.89256 -84.44239	38.89406 -84.50250	Kenton	Exceptional
	Cedar Creek	Mouth to N. Br. Cedar Cr.	0.0-1.7	1.7	38.47647 -84.12288	38.49034 -84.10738	Robertson	Exceptional
	Flour Creek	Mouth to UT	0.0-2.2	2.2	38.78912 -84.34401	38.80180 -84.32476	Pendleton	Exceptional
	Sawyers Fork	Mouth to Headwaters	0.0-3.3	3.3	38.84833 -84.54032	38.82288 -84.58491	Kenton	Exceptional
	*Slabcamp Creek	Mouth to Headwaters	0.0-3.7	3.7	38.09982 -83.32884	38.13916 -83.3548	Rowan	Exceptional

Table 3.1.4-2 (cont.). Candidate reference reach and exceptional streams and segments in Kentucky as defined in 401 KAR 5:030.

Basin	Stream	Segment Description	Segment Mile Points	Total Miles	Lat-Long (downstream)	Lat-Long (upstream)	County	Reference <sup>a</sup> or Exceptional <sup>b</sup>
	Slate Creek	Mouth to Mill Creek	0.0-13.6	13.6	38.21835 -83.69838	38.11217 -83.74668	Bath	Exceptional
	UT of Shannon Cr.	Mouth to Headwaters	0.0-2.2	2.2	38.55437 -83.93334	38.52929 -83.94689	Mason	Exceptional
	Little South Fork	Land Use Change to Headwaters	1.2-5.9	4.7	38.82221 -84.74072	38.82854 -84.68526	Boone	Exceptional
	Doctors Fork	Mouth to Begley Branch	0.0-3.8	3.8	37.67561 -84.968583	37.64618 -84.99938	Boyle	Exceptional
Salt	Doctors Fork	Mouth to Begley Branch	0.0-3.8	3.8	37.67561 -84.96858	37.64618 -84.99938	Boyle	Exceptional
	Indian Creek	Mouth to UT	0.0-0.9	0.9	37.85122 -84.97894	37.85371 -84.96872	Mercer	Exceptional
	Lick Creek	Mouth to 0.1 mi below dam	0.0-4.1	4.1	37.81839 85.21555	37.82618 85.16398	Washington	Exceptional
	UT of Glens Creek	Mouth to Headwaters	0.0-2.3	2.3	37.85772 -85.12185	37.85101 -85.08582	Washington	Exceptional
Green								
	Big Brush Creek	Brush Creek to Poplar Grove Branch	13.0-17.4	4.4	37.3855 -85.59256	37.42748 -86.57935	Green	Exceptional
	Elk Lick Branch	Duck Lick Creek to Barren Fork & Edgaer creeks	3.6-11.8	8.2	36.96006 -86.98834	36.91647 -86.97282	Allen	Exceptional
	Puncheon Creek	Mouth to KY/TN State Line	0.0-4.3	4.3	36.67659 -86.00208	36.62955 -86.00534	Allen	Exceptional
	Thompson Branch	Mouth to KY/TN State Line	0.0-1.5	1.5	36.66124 -86.50066	36.65203 -86.47974	Simpson	Exceptional
Cumber- land	Left Fork Fugitt Creek	Mouth to Headwaters	0.0-1.5	1.5	36.92528 -83.04509	36.93669 -83.02486	Harlan	Exceptional

<sup>a</sup>Reference Reach streams and segments have the greatest biological integrity and intact habitat of those streams in a given bioregion.

<sup>b</sup>Exceptional streams and segments must score "excellent" on the MBI or KIBI based on 50<sup>th</sup> %tile for Mountain, Bluegrass and Pennyroyal and 75<sup>th</sup> %tile for the Mississippi Valley-Interior River Lowlands bioregions. \*Streams that are already Exceptional in 401 KAR 5:030 but are proposed for a segment change based on new data, or to conform to NHD mile points.



**Nonpoint Source Program (NPSP).** The Kentucky Nonpoint Source Pollution Control Program's goal is to protect the quality of Kentucky's surface and groundwater from NPS pollutants, abate NPS threats and restores degraded waters to the extent that water quality standards are met and beneficial uses are supported. The NPSP is achieving this through federal, state, local and private partnerships which promote complementary, regulatory and non-regulatory nonpoint source pollution control initiatives at both statewide and watershed levels.

Nonpoint source pollution is sometimes referred to as runoff or diffuse pollution. Unlike pollution from industrial and sewage treatment plants, NPS pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-produced pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters and even underground sources of drinking water. These pollutants include:

- Excess fertilizers, herbicides and insecticides from agricultural lands and residential areas;
- Oil, grease and toxic chemicals from urban runoff and energy production;
- Sediment from improperly managed construction sites, crop and silviculture lands and eroding streambanks;
- Acid mine drainage; and
- Bacteria and nutrients from livestock, pet wastes and faulty septic systems.

Atmospheric deposition and hydromodification are also sources of nonpoint source pollution. NPS pollution is the number one contributor to water pollution in Kentucky.

Monitoring of streams impacted by NPS pollutants follows KDOW standard protocol; each biosurvey conducted at these stations typically included two biological communities, macroinvertebrates and fishes, to determine the condition of wadeable streams. Also collected were nutrient samples (un-ionized ammonia, nitrite-nitrate, total phosphorus, and total Kjeldahl-nitrogen) in addition to bulk water quality variables (total suspended solids, chlorides, sulfates, alkalinity, hardness and total organic carbon). Physical measurements were also made at time of water quality sample collection; a



multiparameter probe was used to measure pH, temperature, DO, percent DO saturation and specific conductance.

**Probabilistic Monitoring Program (PMP).** KDOW conducts random biosurveys of streams across the commonwealth. Each year the Probabilistic Biosurvey Program Coordinator selects watersheds on the 8-digit HUC level to be monitored in a particular BMU. The target population is all wadeable streams 1<sup>st</sup> through 5<sup>th</sup> order within the HUCs of each BMU. Then a request is sent to EPA's National Health and Environmental Research Laboratory, Office of Research and Development, Corvallis, Oregon, where the EMAP Design Group uses EPA's Reach File Version 3 – Alpha (RF3-Alpha) as a sampling frame. A frequency table is established for the population candidate streams (based on stream order) across the HUCs and based on those frequencies, a random, weighted survey design is utilized to determine those streams and locations of the sample point for the study. A sample size of 50 sites with approximately an equal number in each of the four categories: 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup> + 5<sup>th</sup>. An oversample of 200% (100 sites) for a total of 150 sites including the base sites are derived per study. This oversample provides reserve samples for alternative sites when those initial sites do not conform to target population parameters (e.g. non-wadeable, miss-mapped features), are inaccessible due to safety concerns, or to which access is denied by landowners. Standard protocol dictates that surrogate stream sample sites be selected sequentially from the oversample population when replacement of an initial sample site is necessary. Since the random design is weighted, no regard to replacement of an initial sample site with one of equivalent Strahler order is required.

A biosurvey of the macroinvertebrate community was conducted to determine condition of wadeable streams; additionally, the probabilistic program collected nutrient samples (un-ionized ammonia, nitrite-nitrate, total phosphorus, and total Kjeldahl-nitrogen) in addition to bulk water quality variables (total suspended solids, chlorides, sulfates, alkalinity, hardness and total organic carbon). Physical measurements were also made at time of water quality sample collection; a Hydrolab® multiparameter probe was used to measure pH, temperature, DO, percent DO saturation and specific conductance. For this reporting cycle, probabilistic network consisted of 100 sites (50 stations per BMU (upper Cumberland – 4-Rivers and Green – Tradewater). Those sites, along with

stream names, may be identified in Tables 3.1.4-3; 3.1.4-4; and 3.1.4-5 and Figures 3.1.4-1; 3.1.4-2; and 3.1.4-3.

Table 3.1.4-3. Key to stream names sampled and assessed in the upper Cumberland River basin using probabilistic methodology.

4. Cane Creek	33. Big Clifty
5. Otter Creek	36. Little Poplar Creek
6. Poor Fork	37. Little South Fork
8. Sugar Camp Creek	40. Buck Creek
9. Sulphur Creek	44. Pond Creek
14. Little Laurel River	46. <sup>a</sup> UT Helton Branch
17. Ferris Fork Creek	49. Salt Lick Creek
20. Bear Creek	54. Roaring Fork
22. Sinking Creek	55. <sup>a</sup> UT Big Creek
24. Line Creek	58. Bee Lick Creek
26. Cloverlick Creek	59. Spring Creek
28. Roundstone Creek	64. Straight Creek
30. Bull Run	

<sup>a</sup>UT= Unnamed tributary

Table 3.1.4-4. Key to stream names sampled and assessed in lower Cumberland, Mississippi, Ohio and Tennessee rivers basins using probabilistic methodology.

1. Dry Fork	43. Middle Branch North Fork Little River
3. Hurricane Creek	47. Livingston Creek
7. Rockhouse Creek	48. Claylick Creek
11. <sup>a</sup> UT Mud Creek	51. <sup>a</sup> UT Whippoorwill Creek
13. Bayou de Chien	53. Truman Creek
15. Sinking Fork	61. <sup>a</sup> UT Brush Creek
18. Little White Creek	76. West Fork Clarks River
19. Little Cypress Creek	79. South Fork Bayou de Chien
23. <sup>a</sup> UT to <sup>a</sup> UT Tennessee River	81. Cypress Creek
21. Terrapin Creek	82. Claylick Creek
29. West Fork Mayfield Creek	84. Middle Fork Massac Creek
31. Dry Fork Creek	
39. <sup>a</sup> UT Clarks River	
42. Clarks River	

<sup>a</sup>UT= Unnamed tributary

Figure 3.1.4-1. Probabilistic biological survey sites in the upper Cumberland River basin (key to stream names on previous page).

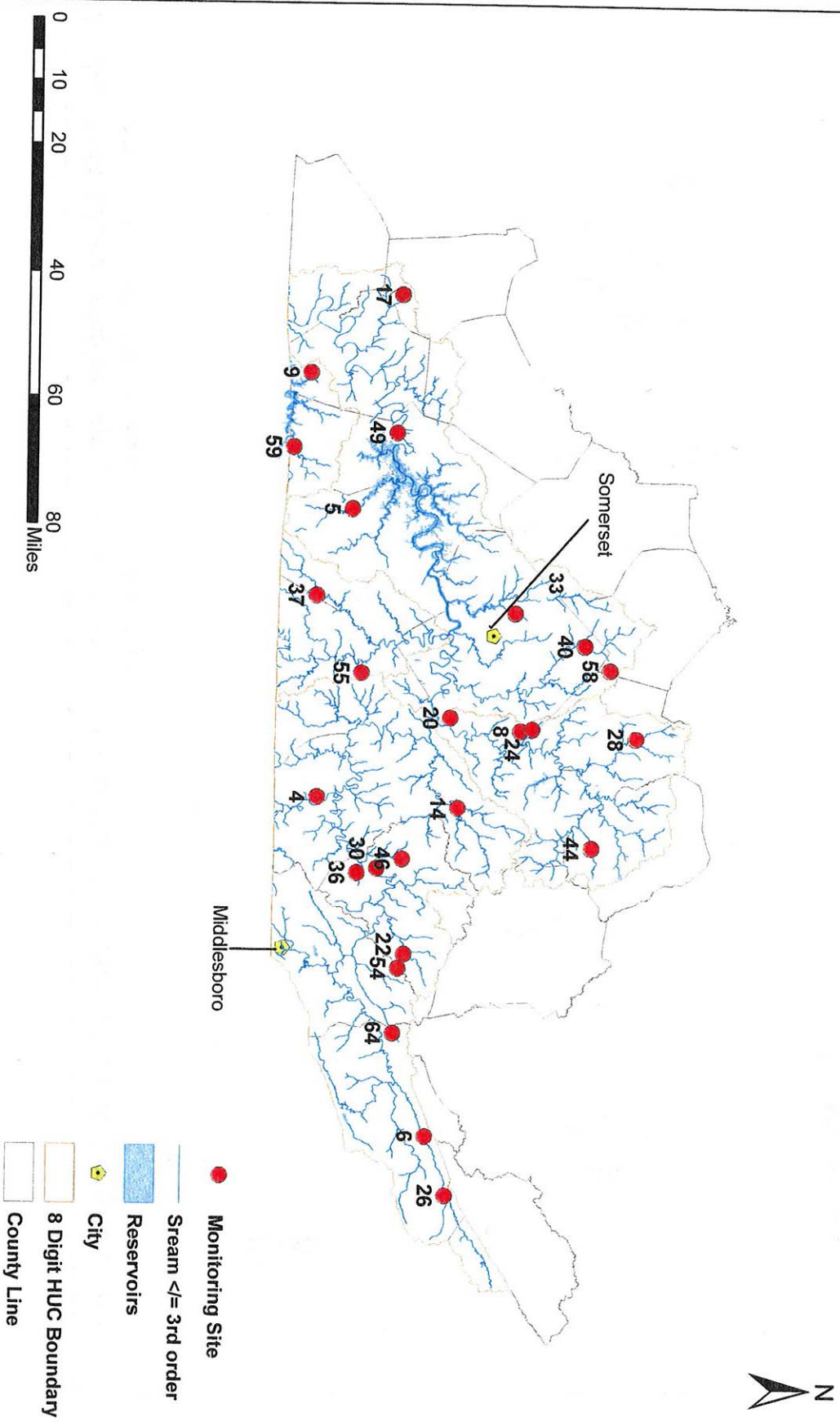




Figure 3.1.4-2. Probabilistic biological survey sites in the lower Cumberland, Mississippi, Ohio and Tennessee rivers basin (key to stream names on previous page).

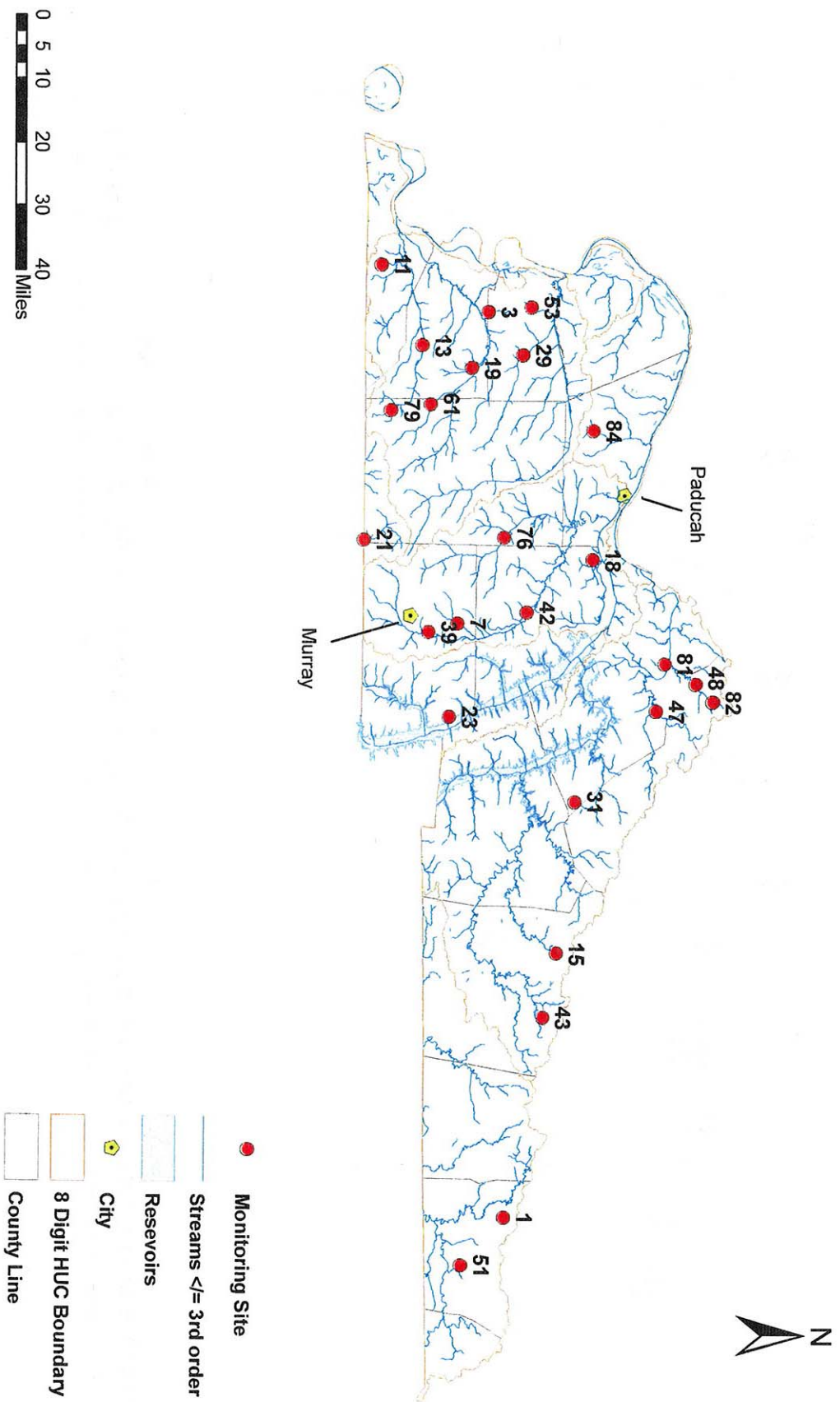
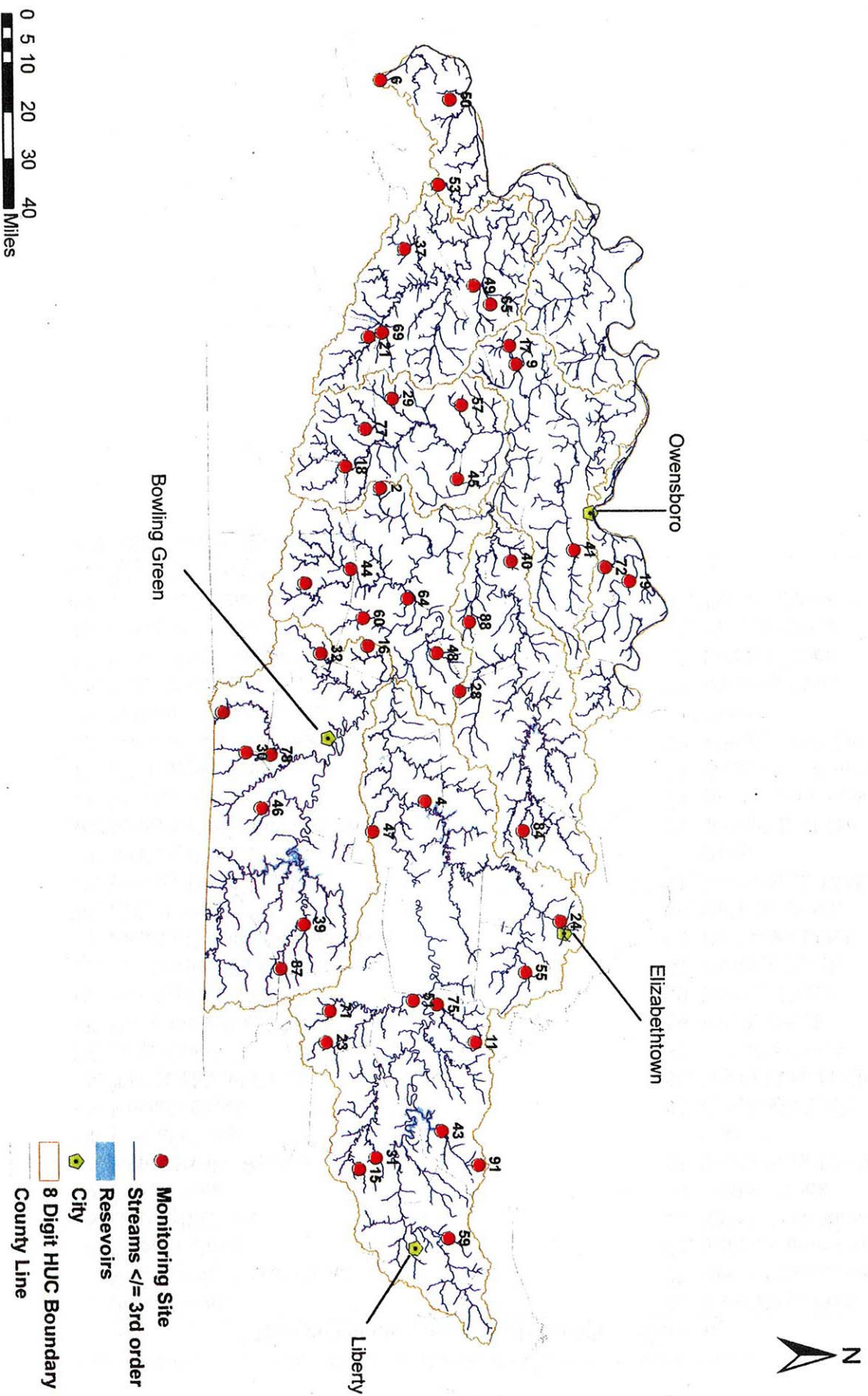


Table 3.1.4-5. . Key to stream names sampled and assessed in Green – Tradewater Basin Management Unit using probabilistic methodology.

1. Pond Creek	46. West Bays Fork
2. West Fork Drakes Creek	47. Beaverdam Creek
4. Dismal Creek	48. Indian Camp Creek
6. Dyerhill Creek	49. <sup>a</sup> UT to <sup>a</sup> UT Slover Creek
9. Deer Creek	50. Sadler Creek
11. Black Snake Branch	51. South Fork Little Barren River
14. Laurel Creek	53. Crooked Creek
15. Russell Creek	55. North Fork Nolin River
16. <sup>a</sup> UT Richland Creek	57. <sup>a</sup> UT Elk Creek
17. Deer Creek	59. Brush Creek
18. Buck Fork Pond River	60. Muddy Creek
19. Blackford Creek	64. Panther Creek
21. Tradewater River	65. Fredricks Ditch
23. East Fork Little Barren River	69. Buffalo Creek
24. Billy Creek	71. South Fork Little Barren River
28. Brushy Pond Creek	72. Wright Bell Ditch
29. <sup>a</sup> UT Drakes Creek	75. Big Brush Creek
30. Middle Fork Drakes Creek	77. West Fork Pond River
31. Sulphur Creek	78. Middle Fork Drakes Creek
32. UT Gasper River	84. Meeting Creek
37. West Fork Donaldson Creek	87. Eaton Branch
39. Falling Timber Creek	88. Muddy Creek
40. Barnett Creek	91. Tallow Creek
41. North Fork Panther Creek	
43. Robinson Creek	
44. Wolf Lick Creek	
45. <sup>a</sup> UT Cypress Creek	

<sup>a</sup>UT= Unnamed tributary

Figure 3.1.4-3. Probabilistic biological survey sites in the Green - Tradewater Basin Management Unit (key to stream names on previous page).





### 3.1.5 Lake and Reservoir Monitoring

Lakes and reservoirs are monitored over the growing season (April – October) for determination of trophic state using the Carlson Trophic State Index (TSI) for chlorophyll *a*. This method of determining trophic state of lakes is convenient as it allows lakes to be ranked numerically according to increasing trophic state (oligotrophic, mesotrophic, eutrophic, and hyper-eutrophic). The growing season average TSI value is used to rank each lake.

Water quality and physical measurements were made in spring, summer and fall, typically with an interval of six to eight weeks to allow sufficient time for seasonal changes to occur. All publicly accessible lakes and reservoirs made-up the population of these resources monitored in Kentucky. Water quality variables, including nutrients (un-ionized ammonia, nitrite-nitrate, total phosphorus, TKN, total soluble phosphorus, soluble reactive orthophosphate and total organic carbon), chlorophyll *a*, standard variables (total suspended solids, chlorides, sulfates, alkalinity and hardness) and a profile of water column physical data (DO, pH, temperature and specific conductance) were monitored at each station per lake. The majority of these waters were small, usually several hundred acres or less in surface area; therefore, one sample station in the forebay was sufficient to characterize the status of the smaller lakes and reservoirs.

The Louisville and Nashville COE districts cooperated in monitoring their dam projects in each BMU. Additionally, Kentucky Lake, a Tennessee Valley Authority (TVA) dam project, was monitored by that agency. The water quality parameters described above were used to determine the trophic status of each reservoir. Multiple monitoring stations were placed in these large reservoirs. Often, the major in-flow and out-flow tributaries of each reservoir were monitored for water quality as well, often including pathogen indicators for recreation support determinations. These tributary streams were assessed for aquatic life use support based on physicochemical data.

Those lakes and reservoirs monitored in the Upper Cumberland – 4-Rivers and Green - Tradewater BMUs are presented in Table 3.1.4-1. Maps of use support assessment results follow in Assessment Results, Section 3.3.

Table 3.1.5-1. Lakes and reservoirs monitored in the Upper Cumberland – 4 Rivers and Green Tradewater Basin Management Units during the 2005 and 2006, respectively.

Lake or Reservoir Name	Size (Acres)	Basin	County	Latitude (dd)	Longitude (dd)
Energy Lake	370	Lower Cumberland	TRIGG	36.86031	-88.01534
Hematite Lake	90	Lower Cumberland	TRIGG	36.89647	-88.04269
Honker Lake	190	Lower Cumberland	LYON	36.90976	-88.02869
Lake Barkley	45,600	Lower Cumberland	LYON	37.01799	-88.21527
Lake Blythe	89	Lower Cumberland	CHRISTIAN	36.92294	-87.49592
Lake Morris	170	Lower Cumberland	CHRISTIAN	36.92889	-87.45500
Arrowhead Lake	37	Mississippi River	BALLARD	37.0365	-89.12816
Burnt Pond	10	Mississippi River	BALLARD	37.04361	-89.11694
Flat Lake	38	Mississippi River	BALLARD	37.04278	-89.09889
Swan Pond	193	Mississippi River	BALLARD	37.012268	-89.117798
Beaverdam Lake	50	Ohio River	BALLARD	37.1425	-89.05417
Buck Lake	19	Ohio River	BALLARD	37.04028	-89.08917
Fish Lake	27	Ohio River	BALLARD	37.0554	-89.09434
Happy Hollow Lake	20	Ohio River	BALLARD	37.15167	-89.04553
Long Pond	56	Ohio River	BALLARD	37.02556	-89.1275
Metropolis Lake	36	Ohio River	MC CRACKEN	37.14779	-88.76665
Mitchell Lake	58	Ohio River	BALLARD	37.15167	-89.04583
Shelby Lake	24	Ohio River	BALLARD	37.18374	-89.03048
Turner Lake	61	Ohio River	BALLARD	37.17278	-89.04166
Kentucky Lake	48,100	Tennessee River	CALLOWAY	37.00326	-88.26727
Cannon Creek Lake	243	Upper Cumberland	BELL	36.68083	-83.70222
Chenoa Lake	37	Upper Cumberland	BELL	36.67583	-83.81944
Corbin City Reservoir	139	Upper Cumberland	LAUREL	36.970241	-84.120201
Cranks Creek Lake	219	Upper Cumberland	HARLAN	36.73907	-83.23758
Dale Hollow Reservoir	4300	Upper Cumberland	CLINTON	36.53709	-85.44618
Lake Cumberland	50,250	Upper Cumberland	RUSSELL	36.86607	-85.1451



Table 3.1.5-1 (cont.). Lakes and reservoirs monitored in the Upper Cumberland – 4-Rivers and Green-Tradewater Basin Management Units during the 2005 and 2006, respectively.

Lake or Reservoir Name	Size (Acres)	Basin	County	Latitude (dd)	Longitude (dd)
Lake Linville	273	Upper Cumberland	ROCKCASTLE	37.38889	-84.34444
Laurel Creek Lake	88	Upper Cumberland	MC CREARY	36.69293	-84.44283
Laurel River Reservoir	6060	Upper Cumberland	WHITLEY	36.96151	-84.26492
Martin's Fork Reservoir	334	Upper Cumberland	HARLAN	36.75	-83.26111
Tyner Lake	87	Upper Cumberland	JACKSON	37.37889	-83.91306
Wood Creek Lake	672	Upper Cumberland	LAUREL	37.21367	-84.19813
Barren River Reservoir	10,000	Green River	ALLEN	36.89233	-86.12259
Briggs Lake	19	Green River	LOGAN	36.88812	-86.83244
Campbellsville City Reservoir	63	Green River	TAYLOR	37.35649	-85.34198
Caneyville City Reservoir	75	Green River	GRAYSON	37.43921	-86.46402
Freeman Lake	160	Green River	HARDIN	37.71644	-85.86987
Grapevine Lake	50	Green River	HOPKINS	37.30552	-87.47700
Green River Reservoir	8210	Green River	TAYLOR	37.25074	-85.33757
Lake Luzerne	55	Green River	MUHLENBERG	37.21278	-87.19611
Lake Malone	826	Green River	LOGAN	37.08019	-87.03289
Lake Washburn	26	Green River	OHIO	37.51812	-86.84842
Lewisburg Lake	51	Green River	LOGAN	36.97056	-86.92667
Liberty Lake	79	Green River	CASEY	37.32237	-84.89506
Metcalfe County Lake	22	Green River	METCALFE	37.04329	-85.60969
Mill Creek Lake (Monroe County)	109	Green River	MONROE	36.68201	-85.70103
Nolin River Reservoir	5790	Green River	GRAYSON	37.27914	-86.24699
Nortonville Lake	27.4	Green River	HOPKINS	37.18085	-87.46592
Rough River Reservoir	5100	Green River	HARDIN	37.61833	-86.49972
Salem Lake	99	Green River	LARUE	37.59129	-85.71097
Shanty Hollow Lake	135	Green River	WARREN	37.1552	-86.38988



Table 3.1.5-1 (cont.). Lakes and reservoirs monitored in the Upper Cumberland – 4-Rivers and Green-Tradewater Basin Management Units during the 2005 and 2006, respectively.

Lake or Reservoir Name	Size (Acres)	Basin	County	Latitude (dd)	Longitude (dd)
Spa Lake	240	Green River	Logan	36.89571	-86.94993
Spurlington Lake	36	Green River	Taylor	37.38519	-85.25506
West Fork of Drakes Creek Reservoir	67	Green River	Simpson	36.72222	-86.5525
Carpenter Lake	64	Ohio River	Daviess	37.84587	-86.9781
Kingfisher Lake	30	Ohio River	Daviess	37.84317	-86.97757
Lake George	53	Ohio River	Crittenden	37.31034	-88.09115
Marion City Lake	38.5	Ohio River	Crittenden	37.31084	-88.09121
Mauzy Lake	84	Ohio River	Union	37.62245	-87.85535
Scenic Lake	18	Ohio River	Henderson	37.87806	-87.56222
Lake Beshear	760	Tradewater	Caldwell	37.14776	-87.68234
Lake Peewee	360	Tradewater	Hopkins	37.35011	-87.52718
Loch Mary	135	Tradewater	Hopkins	37.27343	-87.52087
Moffitt Lake	49	Tradewater	Union	37.57853	-87.85481
Pennyville Lake	47	Tradewater	Christian	37.07242	-87.66499
Providence City Reservoir	36	Tradewater	Webster	37.37583	-87.79639

### 3.2 Assessment Methodology

**General Assessment Methods.** Beginning with the 2005 electronic 305(b) report submittal, the commonwealth began assigning assessed uses, and any associated nonassessed uses, of stream segments and lakes to the appropriate category of the five reporting categories recommended by EPA (2005). Of those categories, two categories were divided to better define assessment results; categories 2B and 5B were added by KDOW to better track assessed segments. Those categories used by the commonwealth are listed in Table 3.2-1. Many waterbody segments had monitored data for only one use assessment, typically aquatic life use.

Table 3.2-1. Reporting categories assigned to surface waters during the assessment process.

<u>Category</u>	<u>Definition</u>
1	All designated uses for water body fully supporting.
2	Assessed designated use(s) is/are fully supporting, but not all designated uses assessed.
2B	Segment currently supporting use(s), but 303(d) listed & awaiting EPA approved delisting, or approved/established TMDL.
3	Designated use(s) has/have not been assessed (insufficient or no data available).
4A	Segment with an EPA approved or established TMDL for all listed uses not attaining full support.
4B	Nonsupport segment with an approved alternative pollution control plan (e.g. BMP) stringent enough to meet full support level of all uses within a specified time.
4C	Segment is not meeting full support of assessed use(s), but this is not attributable to a pollutant or combination of pollutants.
5	TMDL is required.
5B	Segment is not supporting use based on evaluated data; does not require a TMDL.

When considering waters for assessment, KDOW solicited data from a variety of entities. This included other government agencies, including state agencies (e.g. Department of Fish & Wildlife) and federal agencies such as COE, F&WS, USGS, and TVA. Also, data from universities and ORSANCO were considered.

Generally, data older than five years were not considered for assessment; however, assessment decisions were made on a case-by-case basis—not all data older



than five years were excluded from consideration. Data older than five years were considered if they were the only data available for a waterbody.

A number of causes (pollutants) in EPA's 2006 IR guidance were considered pollution rather than pollutants. A waterbody found not supporting a use and shown to be impaired by pollution, without identified pollutants, does not require a TMDL, rather an alternative plan to bring the use back to full support (Category 4B). Causes considered pollution are found in Table 3.2-2. The rationale behind pollutant vs. pollution is that a pollutant is a measurable variable, and its presence above criteria results in designated use impairment. It is the causal variable, not the indicator or response variable of one or more pollutants (sedimentation/siltation, total phosphorus, ammonia, methylmercury, etc). An example of pollution is alteration in stream-side or littoral vegetative cover, a category that in and of itself may not directly attribute to impairment or water quality degradation. The loss of this vegetative integrity can result in excess nutrients and sedimentation/siltation (pollutants) that will subsequently affect biological communities, water quality, in-stream habitat and temperature. The previous example also serves to clarify why "habitat assessment (streams)" is also considered pollution. Pollutants such as sedimentation/siltation, nutrients, or water temperature are listed with those nonsupporting segments, directly identifying the pollutant(s) and associated pollution that should be addressed to restore full use support.

The cause "habitat assessment (streams)" was the most commonly reported pollution for streams not supporting aquatic life use based on biological community results. It should be noted that streams with this identified pollution make their way on the 303(d) list since it is almost never without associated pollutants such as sedimentation/siltation because riparian vegetation to abates excess sedimentation, removes excess nutrients and ameliorates water temperature. In the uncommon circumstance where "habitat assessment (streams)" was the only reported "cause," it was recognized that pollutants had not been observed or measured that were impacting the biological community(s). In these instances the cause, "impairment unknown," was listed, which as a pollutant-surrogate, places it on the 303(d) list. In these instances more intensive investigation is needed to determine individual pollutants than the initial



Table 3.2-2. List of those causes considered pollution by the KDOW (ADB numerical codes listed).

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(67) Abnormal fish histology (lesions)
(84) Alteration in stream-side or littoral vegetative covers
(85) Alterations in wetland habitats
(105) Benthic-macroinvertebrate bioassessment (streams)
(150) Chlorophyll <i>a</i>
(161) Combination benthic/fishes bioassessments (streams)
(162) Combined biota/habitat bioassessments (streams)
(181) Debris/floatable/trash
(205) Dissolved oxygen saturation
(218) Eurasian water milfoil, <i>Myriophyllum spicatum</i>
(227) Excess algal growth
(228) Fish-passage barrier
(229) Fish kills
(230) Fishes bioassessment (streams)
(243) Habitat assessment (streams)
(266) Lake bioassessment
(270) Low flow alterations
(312) Non-native aquatic plants
(313) Non-native fish, shellfish, or zooplankton
(316) Odor threshold number
(319) Other flow regime alterations
(331) Particle distribution (embeddedness)
(336) Periphyton (Aufwuchs) indicator bioassessments (stream)
(368) Secchi disk transparency
(387) Suspended algae
(402) Total organic carbon
(412) Trophic State Index
(422) <i>Dreissena polymorpha</i> , zebra mussel
(445) Abnormal fish deformities, erosions, lesions, tumors
(446) Habitat assessment (lakes/reservoirs)
(450) High flow regime
(459) Taste and odor
(460) Aquatic plants (native)
(465) Fish advisory (no restriction)
(466) Sediment screening value exceedence
(471) Bottom deposits
(477) Bacterial slimes
(478) Aquatic plants (macrophytes)
(479) Aquatic algae

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biosurvey provided. In this example the waterbody or segment will be assigned to category 5 (303[d] list) with the cause, habitat assessment (streams), included in the list of impairments. It is recognized that to restore aquatic life use, pollution (e.g. riparian vegetative zone) must be rectified as part of the process in addressing the pollutant(s), in this example sedimentation/siltation.

Another group of causes considered pollution that may be recognized in stream biosurveys are those indicating non-native aquatic plants, non-native fish, shellfish, or zooplankton, for example zebra mussel, *Dreissena polymorpha*. While these conditions are undesirable and can have a negative impact on the native plant or animal communities in a waterbody, non-natives, almost without exception, have been introduced accidentally or intentionally via commerce or recreation (ship ballasts, boating, aquarists, sportspersons [non-native trout], etc.). To develop and implement a TMDL to eliminate these non-natives would often be more damaging to the environment (e.g. biocides or mechanical removal) then leaving them in-place because they are often widespread and prevalent. For example, if the non-native carp, *Cyprinus carpio*, found in many perennial streams and reservoirs in the state, was considered a pollutant rather than pollution, a TMDL would be required to address this in thousands of stream miles and reservoir acres. These examples are instances where the occurrence of impairments considered pollution (non-natives) alone will not result in a category 5 listing, rather a category 2 listing if all biological community metrics indicate the aquatic life use is supporting.

Causes that may be indicators of nonsupport aquatic life use but are not pollutants themselves: 1) benthic macroinvertebrate bioassessment (streams); 2) chlorophyll *a*; 3) combination benthic/fishes bioassessment; 4) combined biota/habitat bioassessments (streams); 5) dissolved oxygen saturation; 6) excess algal growth; 7) fishes bioassessment (streams); 8) lake bioassessment; 9) periphyton (aufwuchs) indicator bioassessments (stream); 10) Secchi disk transparency; 11) suspended algae; 12) trophic state index; and 13) fish advisory – no restriction, are considered pollution. The KDOW uses macroinvertebrates and fishes routinely to make aquatic life use support determinations in streams. These biological indicators provided the data necessary to produce KDOW's multimetric indices through correlation with stressors resulting in the assignment of tolerance levels based on taxon, percent dominance of tolerant taxa, percent intolerant

taxa, such as Ephemeroptera (mayflies), feeding strategy (e.g. filterers or scrapers), as well as watershed drainage area which naturally influences the populations within each community. While these biological communities are robust environmental indicators of water quality and integrity of habitat, they are not pollutants, but a manifestation of those tolerant organisms exploiting conditions that will not support clean-water, intolerant populations. Through physicochemical data taken at time of biosurveys and habitat assessment (in-stream habitat and land use observations), the most detrimental pollutants are usually recognized as contributors to the degraded biological community. Most stream miles in Kentucky not supporting aquatic life use were impaired primarily by the pollutants sedimentation/siltation (habitat smothering), nutrient enrichment, and “cause unknown,” in addition to pollution in the form of habitat alterations (often riparian zone related). All these pollutants affect in-stream habitat or physicochemical variables that manifest in the biological community structure. In cases where no pollutants were recognized, “cause unknown” is listed, which places the waterbody/segment in category 5, requiring a TMDL.

The total number of assessed stream miles was determined by adding the miles represented by the site-specific random survey (not extrapolated data) and the miles assessed by targeted monitoring. In other words, miles assessed by targeted monitoring in wadeable streams were included in miles assessed by the random survey (1<sup>st</sup> – 5<sup>th</sup> Strahler order). However, results were also presented separately for targeted and random (extrapolated) total miles.

### 3.2.1 Aquatic Life Use

The water quality and biological data provided by the programs described in the preceding sections were used to assess use support in rivers and streams. Table 3.2.1-1 shows the designated uses of Kentucky waters and the indicators employed to make those use support determinations. Given the comprehensive suite of parameters sampled by KDOW for many stream assessments, both biological and physicochemical, a determination can typically be made as to the cause(s) and source(s) of pollutant or pollution affecting the resource. Further study during TMDL development will lead to specific definition of causes and sources. Data were categorized as “monitored” or



“evaluated.” Monitored data were derived from site-specific surveys and generally no more than five years old. Typically, data older than five years were considered “evaluated,” but this did not change the assessment category a waterbody and/or segment had been assigned unless there were more recent “monitored” data. In some instances where conditions were believed to have remained mostly unchanged, monitored data collected prior to 1995 were still considered valid, and waters described by these data were categorized as monitored. Additionally, data from the random survey network were used. Like the targeted stations, each random survey station was used to assess a limited reach of stream around the sample point. Few evaluated waters remain in the assessment database. Although all efforts in the watershed initiative were to gather defensible, monitored data, there were some monitoring data more than five years old, strong anecdotal information, and extrapolation of discharge data that resulted in evaluated assessments.

**Water Quality Data.** Chemical data collected by KDOW and others were assessed according to EPA guidance (U.S. EPA 1997). Water quality data were compared to criteria contained in Kentucky Water Quality Regulations (401 KAR 5:031). The segment fully supported WAH use when criteria for dissolved oxygen, un-ionized ammonia, temperature and pH were not met in 10 percent or less of the samples collected. Impaired, partial support was indicated if any one criterion for these parameters was not met in 11-25 percent of the samples. A segment was impaired, not supporting, if any one of these criteria was not met in more than 25 percent of the samples.

Data for mercury, cadmium, copper, iron, lead and zinc were analyzed for exceedences of acute criteria listed in state water quality standards regulations using at least three years of data. The segment fully supported WAH use if all criteria were met at stations with quarterly or less frequent sampling, or if only one exceedence occurred at stations with monthly sampling. Impaired, partial support was indicated if any one criterion was not met more than once but in less than 10 percent of the samples. The segment was impaired, not supporting if criteria were exceeded in greater than 10 percent of the samples. The assessment criteria were closely linked to the way state and federal water quality criteria were developed. Aquatic life was considered protected if, on average, the

Table 3.2.1-1. Designated uses in Kentucky waters and the indicators used to assess level of support.

Use	Aquatic Life	Recreation	Fish Consumption	<sup>a</sup> Drinking Water
Core Indicators	<u>Stream:</u> 1-3 biological communities: macroinvertebrates, diatoms and fishes Dissolved oxygen Temperature pH Specific conductance  <u>Lake/Reservoir:</u> Dissolved oxygen Temperature pH Specific conductance Fish kills	<u>Stream:</u> Pathogen indicators: fecal coliform; <i>E. coli</i> pH  <u>Lakes/Reservoir:</u> Pathogen indicators: fecal coliform or <i>E. coli</i> pH	Mercury PCBs	Inorganic chemicals Organic chemicals Pathogen indicators: fecal coliform, <i>E. coli</i>
Supplemental Indicators	Chlorophyll- <i>a</i> Trophic State Index (TSI) Secchi depth Indicator health (vigor) Chemical Sediments	Nuisance macrophytes Nuisance macroscopic algal growth Nuisance algal blooms Suspended sediment Chemical	Other chemicals of concern found in water quality standards	Odor Taste Treatment problems caused by poor water quality

<sup>a</sup>All core indicators are based on "at the tap" MORs received from PWS

acute criteria were not exceeded more than once every three years. Data were also compared to chronic criteria. Observations that equaled or were only slightly greater than chronic criteria were not considered to exceed water quality standards. Toxic criteria were assessed based on 12 monthly samples at the rotating watershed ambient water quality network and generally 36 samples from the primary ambient water quality network. The segment fully supported WAH use if all criteria met or exceeded only once. Impaired, partial support was assessed if any criterion was not met more than once, but in less than 10 percent of samples. The segment was impaired, not supporting if criteria were exceeded in greater than 10 percent of samples.

**Biological Data (streams).** Decisions about use attainment for aquatic life were primarily made using biological data obtained from monitoring programs within the KDOW and other agencies. There are a number of reasons biological data are so important in making level of support decisions for aquatic life use. Biological

communities (indicators) integrate their environment and thus serve as good indicators of the conditions (physical, chemical, and habitat) they live in. The core indicators for bioassessment are outlined in Table 3.2.1-2. Level of use support was dependent on the indicator community(s) health and integrity, with supplemental physicochemical and habitat data. These results were applied for assessment purposes as outlined in Table 3.2.1-2.

Macroinvertebrates have been used extensively in water quality monitoring and impact assessment since the early 1900s. Today, macroinvertebrates are used throughout the world in water quality assessment as environmental indicators of biological integrity, to describe water quality conditions or health of the aquatic ecosystem, and to identify causes (pollutants) of impairment. This indicator community is relatively sedentary, spending a significant portion of their life cycle in the aquatic environment. Various populations of a community are dependent on multiple habitats in the water column, occupy more than one consumer level throughout the food web (herbivores, omnivores, and carnivores) and, significantly, many sensitive taxa (benthos) live in or on the sediments of streams. These characteristics and habits make this a key indicator group of their environment. KDOW defines benthic macroinvertebrates as organisms large enough to be seen by the unaided eye, can be retained by a U.S. Standard Number 30 sieve (28 mesh/inch, 600  $\mu$ m openings), and live at least part of their life cycle within or upon available substrates of a waterbody. In addition to determining use support level, biomonitoring will identify those Exceptional Waters (401 KAR 5:030) (those waters that are among the most biologically diverse and represent biological integrity to a high degree in a given bioregion) occurring across the commonwealth.

The evaluation of fish community structure is an important component of biological monitoring providing reliable assessments for the CWA, Section 305(b). The Kentucky Index of Biotic Integrity (KIBI) was developed based on reference conditions and tolerances and community feeding structure of species present. Advantages of using fish as biological indicators include their widespread distribution, utilization of a variety of trophic levels, stable populations during summer months, and the availability of extensive life history information (Karr et al. 1986).



Table 3.2.1-2. Biological criteria for assessment of warm water aquatic habitat (streams) use support<sup>a</sup>.

<u>Indicator</u>	<u>Fully Supporting</u>	<u>Partial Support</u>	<u>Nonsupport</u>
Algae	Diatom Bioassessment Index (DBI) Classification of excellent or good; biomass similar to reference/control or STORET mean.	DBI classification of fair; increased biomass (if nutrient enriched) of filamentous green algae.	DBI classification of poor; biomass very low (toxicity), or high (organic enrichment).
Macroinvertebrates	Macroinvertebrate Bioassessment Index (MBI) excellent or good, high EPT, sensitive species present.	MBI classification of fair, EPT lower than expected in relation to available habitat, reduction in RA of sensitive taxa. Some alterations of functional groups evident.	MBI classification of poor; EPT low, TNI of tolerant taxa very high. Most functional groups missing from community.
Fishes	Index of Biotic Integrity (IBI) excellent or good; presence of rare, endangered or species of special concern.	IBI fair.	IBI poor, very poor, or no fish.

<sup>a</sup>Acronyms used in this table: EPT= Ephemeroptera, Plecoptera, Trichoptera; RA= relative abundance; TNI- total number of individuals

Algal (primarily diatoms) communities are important water quality indicators, particularly as it relates to trophic status (nutrient or organic enrichment) and toxicity conditions. This indicator group is critical to the food web of streams, beginning the process of primary production through photosynthesis. The Diatom Bioassessment Index (DBI) is used to assess this indicator community.

**Federally Threatened and Endangered Species.** Waters with federally threatened or endangered species in November 1975 have an existing “use” of Outstanding State Resource Water, and the loss or significant decline of one of these populations constitutes an impairment of use.

**Lakes and Reservoirs.** Lakes and reservoirs were assessed for aquatic life by measuring several physicochemical indicators and reported fish kills. The lack of a direct biological indicator is primarily due to most of this resource being manmade, thus

supporting altered and unnatural biological communities that are composed almost exclusively of tolerant species (e.g. Tubificidae, *Chironomus* spp., *Chaoborus* spp., *Glyptotendipes* spp., etc.) that are capable of exploiting this naturally low DO-stressed environment. Thus, the core and supplemental indicators shown in Table 3.2.1-1 are of utmost importance to assure water quality conditions are suitable for supporting sportfish and associated prey fishes. Populations of these fishes are the primary concern for aquatic life use being met in these created environments. Table 3.2.1-3 outlines those criteria used in making use assessment decisions.

Trophic state was assessed in lakes and reservoirs using the Carlson Trophic State Index (TSI) for chlorophyll-*a*. This method is convenient because it allows lakes and reservoirs to be ranked numerically according to increasing eutrophy, and it also provides for a distinction between oligotrophic, mesotrophic, eutrophic, and hyper-eutrophic lakes and reservoirs. The growing season (March – October) average TSI value was used to rank each lake. Areas of lakes that exhibited trophic gradients or embayment differences often were analyzed separately.

### 3.2.2 Primary Contact Recreation Use Support

Fecal coliform or *Escherichia coli* and pH data were used to indicate the degree of support for primary contact recreation (PCR) (swimming) use. PCR assessment was based on six monthly grab samples collected during the recreation season of May – October. The use fully supported if the fecal coliform bacteria criterion of greater than 400 colonies per 100 mL (greater than 240 colonies per 100 mL for *E. coli*) was not met in less than 20 percent of samples; it was impaired, partial support, if either criteria were not met in 25-33 percent of samples; and impaired, nonsupport, if either criteria were not met in greater than 33 percent of samples. Secondary contact recreation (SCR) was also assessed following the same method using fecal coliform data at the concentration of greater than 2000 colonies per 100 mL. Streams with pH less than 6.0 SU or greater than 9.0 SU were considered full support if these criteria were exceeded once, but in less than 10 percent of samples collected in the recreation season; impaired, partial support, if the standard was exceeded more than once, but in less than 10 percent of the samples during

Table 3.2.1-3. Criteria for lake and reservoir use support classification.

Category	Fish Consumption	Warmwater Aquatic Habitat	Secondary Contact Recreation	Domestic Supply
Not Supporting:	(Pollutant specific)	(At least two of the following criteria)	(At least one of the following criteria)	(At least one of the following criteria)
Supporting:	Methylmercury > 1.00 ppm (fish tissue)	Fish kills caused by poor water quality	Widespread excess macrophyte/macroscopic algal growth	Chronic taste and odor complaints caused by algae
		Severe hypolimnetic (deepest layer in a thermally stratified lake or reservoir) oxygen depletion	Chronic nuisance algal blooms	Chronic treatment problems caused by poor water quality
		Dissolved oxygen average less than 4 mg/L in the epilimnion (upper most layer of water in a thermally stratified lake or reservoir)		Exceeds drinking water MCL
		PCBs > 1.9 ppm (fish tissue)		
Partially Supporting: (At least one of the following criteria)	Methylmercury > 0.30 – 1.00 ppm (fish tissue)	Dissolved oxygen average less than 5 mg/L in the epilimnion	Localized or seasonally excessive macrophyte/macroscopic algal growth	Occasional taste and odor complaints caused by algae
		Severe hypolimnetic oxygen depletion	Occasional nuisance algal blooms	Occasional treatment problems caused by poor water quality
		Other specific cause (e.g. low pH)	High suspended sediment concentrations during the recreation season	
Fully Supporting:	Methylmercury < 0.30 ppm and PCBs < 0.2 ppm	None of the above	None of the above	None of the above



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the recreation season; and impaired, nonsupport, if the criterion was exceeded in more than 10 percent of samples during the recreation season.

### 3.2.3 Other Data Sources

**Discharge Monitoring Reports (DMRs).** Discharge monitoring report (DMR) data, collected by Kentucky Pollutant Discharge Elimination System (KPDES) permit holders, were assessed through KDOW's permit compliance database. Depending on the relative sizes of the wastewater discharge, the receiving stream and the severity of the permit exceedences, it sometimes was possible to assess in-stream uses as nonsupporting either AL or PCR. Because in-stream data were usually not collected, stream assessments based only on DMR data were considered evaluated, not monitored, and these segments were assigned to category 5B.

**Corps of Engineers (COE) Reservoir Projects.** Dam projects on major streams in Kentucky were monitored with the cooperation of the COE. During the Interagency Monitoring and Planning Meeting those reservoirs in the BMU of focus were identified and a cooperative effort between KDOW and COE resulted. Reservoir water-quality variables were monitored over the growing season (March – October) as were major in-flow and out-flow tributaries of these reservoirs. Aquatic life use support level was determined using these monitored data for reservoir and monitored tributaries. The Nashville and Louisville COE districts manage those projects in Upper Cumberland – 4-Rivers BMU and Green – Tradewater BMU, respectively.

### 3.2.3 Fish Consumption Use Support

Fish consumption, in conjunction with aquatic life use, assesses attainment of the fishable goal of the Clean Water Act. Assessment of the fishable goal was separated into these two categories in 1992 because the fish consumption advisory does not preclude attainment of the aquatic life use and vice versa. Separating fish consumption and aquatic life use support gives a clearer picture of actual water quality conditions. Table 3.2.1-1 relates those criteria used to make fish consumption use support decisions, and Table 3.2.1-3 shows the concentrations of methylmercury and PCBs that result in a specific level of support; these concentrations apply to lakes, reservoirs and streams.

Kentucky revised its methodology for issuing fish consumption advisories in 1998 to a risk-based approach patterned after the Great Lakes Initiative. The risk-based approach generally is more conservative than the Food and Drug Administration (FDA) action levels that were used previously. For example, the FDA action level for mercury was 1.0 mg/Kg, but the risk-based number for issuing an advisory is as low as 0.12 mg/Kg. As a result of this change in methodology, a statewide advisory was issued in April 2000 for children under six and women of childbearing age to not consume more than one meal per week of any fish from Kentucky waters because of mercury. However, EPA (2001a) issued a draft mercury water quality criterion expressed as a methylmercury concentration in fish tissue of 0.30 mg/Kg. Therefore, for purposes of 305(b) reporting, waters were not considered impaired unless fish exhibited methylmercury tissue concentrations of at least 0.30 mg/Kg. In other words, the fish tissue concentration triggering the statewide advisory (0.12 mg/Kg) was considered more stringent than water quality standards.

Other than the statewide advisory for mercury explained above, the following criteria were used to assess support for the fish consumption use:

- Fully supporting- no fish consumption restrictions or bans in effect; highest species concentration  $\leq 0.30$  mg/Kg
- Impaired: Partial support- “restricted consumption,” fish consumption advisory in effect for general population or a subpopulation that potentially could be at a greater cancer risk (e.g. pregnant women, children); highest species concentration  $> 0.30$  mg/Kg – 1.00 mg/Kg. Restricted consumption was defined as limits on the number of meals consumed per unit time for one or more fish species
- Impaired: Not supporting- a no consumption fish advisory or ban in effect for general population or a subpopulation that potentially could be at greater risk, for one or more fish species, or a commercial fishing ban in effect; highest species concentration  $> 1.00$  mg/Kg.



### 3.2.4 Drinking Water Supply

Drinking water use support was determined in several ways (Table 3.2.1-1). First, compliance with maximum contaminant levels (MCLs) in finished water was determined by the annual average of quarterly samples. These MCL data were gleaned from monthly operating reports (MORs) submitted to KDOW, Drinking Water Branch, from treatment facilities. Drinking water use assessments in reservoirs were supplemented by surveys of drinking water operators on any taste and odor problems and use of biocides (Table 3.2.1-1). In-stream water quality data generally were not available to assess drinking water use.

### 3.2.5 Causes and Sources

Causes (pollutants and pollution) and sources were categorized according to EPA guidance. Causes for primary contact recreation, fish consumption, and water supply usually were easily identified. The majority of segments or waterbodies not supporting aquatic life use were determined by biological monitoring supplemented by monitoring of select physicochemical parameters. Causes and sources of impairment may not be evident in the field and there may be other pollutants contributing to use impairment that were not listed. Once on the 303(d) list, subsequent intensive monitoring and watershed reconnaissance of land uses will more fully identify causes and sources of impairments.

### 3.2.6 Determination of Assessment Segments

Once an assessment was made on a waterbody, an appropriate segment or portion of the waterbody representative of the monitored area was determined. Part of this determination was based on the type of monitoring (e.g. physicochemical, biological, bacteriological, fish tissue, or lake/reservoir).

**Aquatic Life, Recreation and Fish Consumption Uses.** This monitoring activity occurred throughout the state at the Primary Ambient Water Quality Stations (Primary Network) and in the Rotating Watershed Stations particular to the BMU cycle phase. Since the Primary Network stations are located on large streams and rivers, these assessment segments are taken downstream and upstream of significant streams entering the monitored stream. Significance of tributaries is based on the watershed area and

relative volume. Another important factor considered in defining segments is significant changes in land use, such as from a contiguous forested area to a non-forested area with fragmented riparian vegetative zone. Habitat conditions along the corridor are assessed for the same reasons as physicochemical parameters for biological communities. Since many of KDOW's PCR-SCR (recreation) monitoring locations are associated with the ambient water quality network, the same rationale is used to define these segments and typically is the same as the defined segment for the accompanying aquatic life use assessment.

Waters assessed for aquatic life use with biological community data often will be of shorter segment reach since biological indicators are typically more responsive to subtle changes in water quality as they integrate these conditions over a relatively long time. Typically the smaller the watershed, a proportionately greater segment will be defined since the conditions and influences from surrounding land use were similar and localized. In larger watersheds, typically greater than five square miles, proportionately smaller assessment segments are defined because of the increased potential of pollutant sources and habitat influences. These segments often are defined by upstream and downstream tributaries judged to be of significant drainage area to the receiving stream.

Fish consumption segments are defined in a similar method as those reaches assessed using only physicochemical or bacteria data. Many fish species are relatively far ranging, and that factor has significant consideration in defining segments. Also, with the plethora of sources, and the likelihood that much of the mercury contamination in waters comes via atmospheric deposition, relatively long reaches are often defined when making these assessments. However, significant tributaries are often used to make the upstream and downstream termini, with less consideration given to habitat for the reasons given above.

**Drinking Water Use.** Since this use was assessed utilizing finished water data supplied by Public Water Systems (PWS), the assessed segments were usually conservative when applied to the source water. The assessment segments were typically taken from the point of withdrawal and extended upstream one mile. A few exceptions to that rule occurred when multiple uses were assessed (e.g. fish tissue, aquatic life) in the same general area of PWS withdrawal points. Those segments were usually longer (see

section above on these use assessment segments) in order to accommodate other uses that overlapped the PWS withdrawal point. For reservoirs, the assessment was applied to the waterbody.



